



# **NAVAL POSTGRADUATE SCHOOL**

**MONTEREY, CALIFORNIA**

## **THESIS**

**PROOF-OF-CONCEPT PART TASK TRAINER FOR  
CLOSE AIR SUPPORT PROCEDURES**

by

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June 2016

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<b>REPORT DOCUMENTATION PAGE</b>			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.				
<b>1. AGENCY USE ONLY</b> (Leave blank)		<b>2. REPORT DATE</b> June 2016		<b>3. REPORT TYPE AND DATES COVERED</b> Master's Thesis
<b>4. TITLE AND SUBTITLE</b> PROOF-OF-CONCEPT PART TASK TRAINER FOR CLOSE AIR SUPPORT PROCEDURES			<b>5. FUNDING NUMBERS</b>	
<b>6. AUTHOR(S)</b> Jesse T. Attig				
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> Naval Postgraduate School Monterey, CA 93943-5000			<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> N/A			<b>10. SPONSORING / MONITORING AGENCY REPORT NUMBER</b>	
<b>11. SUPPLEMENTARY NOTES</b> The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol number NPS.2016.0023-IR-EM2-A.				
<b>12a. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited			<b>12b. DISTRIBUTION CODE</b>	
<b>13. ABSTRACT (maximum 200 words)</b>  Transitioning between two training phases of the close air support (CAS) syllabus can be difficult for pilots under instruction (PUIs). The level and variety of skills needed for each stage may not be acquired in the previous step, which makes it difficult for the pilot to take the most value from the current stage of training. By providing PUIs with supplemental training solutions that aim to bridge those training gaps, it may be possible to increase the value of the ultimate, but time-limited, training opportunities like simulator and actual flight events. This research prototyped a supplemental training solution that offers a context-relevant, immersive virtual environment that removes the need to fly or operate the aircraft system, thus enabling the trainee to focus only on improving the skills related to problem schema (communication, decision making, and CAS procedures). The resulting system enables repetitive, individual training of CAS communication and procedure skills similar to "chair flying" combined with tactically correct examples of CAS missions used during "chalk talks." An informal user study indicated this approach has the potential to make the transition to the simulator or aircraft much easier and could offer a viable training solution in an increasingly fiscally constrained environment.				
<b>14. SUBJECT TERMS</b> part-task trainer, close air support, virtual environment, aviation			<b>15. NUMBER OF PAGES</b> 109	
			<b>16. PRICE CODE</b>	
<b>17. SECURITY CLASSIFICATION OF REPORT</b> Unclassified	<b>18. SECURITY CLASSIFICATION OF THIS PAGE</b> Unclassified	<b>19. SECURITY CLASSIFICATION OF ABSTRACT</b> Unclassified	<b>20. LIMITATION OF ABSTRACT</b> UU	

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**PROOF-OF-CONCEPT PART TASK TRAINER FOR CLOSE AIR SUPPORT  
PROCEDURES**

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Submitted in partial fulfillment of the  
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**MASTER OF SCIENCE IN  
MODELING, VIRTUAL ENVIRONMENTS AND SIMULATION (MOVES)**

from the

**NAVAL POSTGRADUATE SCHOOL  
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## **ABSTRACT**

Transitioning between two training phases of the close air support (CAS) syllabus can be difficult for pilots under instruction (PUIs). The level and variety of skills needed for each stage may not be acquired in the previous step, which makes it difficult for the pilot to take the most value from the current stage of training. By providing PUIs with supplemental training solutions that aim to bridge those training gaps, it may be possible to increase the value of the ultimate, but time-limited, training opportunities like simulator and actual flight events. This research prototyped a supplemental training solution that offers a context-relevant, immersive virtual environment that removes the need to fly or operate the aircraft system, thus enabling the trainee to focus only on improving the skills related to problem schema (communication, decision making, and CAS procedures). The resulting system enables repetitive, individual training of CAS communication and procedure skills similar to “chair flying” combined with tactically correct examples of CAS missions used during “chalk talks.” An informal user study indicated this approach has the potential to make the transition to the simulator or aircraft much easier and could offer a viable training solution in an increasingly fiscally constrained environment.

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## LIST OF ACRONYMS AND ABBREVIATIONS

1PP	First-Person Perspective
2PP	Second-Person Perspective
3D	Three-Dimensional
3PP	Third-Person Perspective
AAR	After-Action Reviews
ACEOI	Automated Communication Electronic Operation Instruction
ACM	Airspace Coordination Measures
ADL	Advanced Distributed Learning
AR	Armed Reconnaissance
ATS	Aviation Training Systems
BP	Battle Position
CAS	close air support
COBRA-T	Computer Based Rehearsal and Assessment Trainer
COTS	Commercial Off the Shelf
DASC	Direct Air Support Center
DIS	Distributed Interactive Simulation
EEG	Electroencephalogram
EKB	Electronic Kneeboard
FAC	Forward Air Controller
FP	Firing Point
FPS	Frames Per Second
FW	Fixed Wing
HA	Holding Area
HMLA	Helicopter Marine Light Attack
IP	Instructor Pilot
IRB	Institutional Review Board
ITX	Integrated Training Exercises
IUT	Instructor Under Training
JFIRE	Joint Application of Firepower
JSON	JavaScript Object Notation

JTAC	Joint Terminal Attack Controller
KILSWITCH	Kinetic Integrated Low-cost SoftWare Integrated Tactical Combat Handheld
KML	Keyhole Markup Language
LLL	Low Light Level
MATSS	Marine Aviation Training System Sites
MAW	Marine Aircraft Wing
MAWTS	Marine Aviation Weapons and Tactics Squadron
MFD	Multi-Functional Display
NTTP	Naval Tactics, Techniques, and Procedures
OAD	Objective Area Diagram
OAS	Offensive Air Support
PTO	Pilot Training Officer
PUI	Pilot Under Instruction
RW	Rotary Wind
SAVAGE	Scenario Authoring and Visualization for Advanced Graphical Environments (
SCAR	Strike Coordination and Reconnaissance
SME	Subject Matter Experts
T&R	Training and Readiness
TA	Task Analysis
TC-DIM	Training-Center Diffusion of Innovation Model
TEFACHR	Threat, Enemy situation, Friendly update, Artillery, Clearance authority, Hazards, and Remarks/restrictions
TMS	Type Model Series
TOT	Time On Target
TPG	Tactical Pocket Guide.
TTPs	Tactics, Techniques, and Procedures
TVDL	Tactical Video Down Link
VE	Virtual Environment
VR	Virtual Reality
WTI	Weapons and Tactics Instructor

## **ACKNOWLEDGMENTS**

I would first like to thank my wife for her enduring commitment to always be there no matter where life takes us. Thank you for your understanding during this time, I could not have done it without you.

To Dr. Sadagic, I want to thank you for all of your hard work. Your persistence and dedication to ensuring everything got done correctly is what made this thesis possible.

To the Visual Simulation and Game-Based Technology Group at Naval Postgraduate School, thank you for all of your help. Without the help of Michael Guerrero and Eric Heine the interfaces would never have gotten this far along.

Lastly, I would like to thank all of the skid pilots who took the time to complete the online surveys and to the group that took the time to provide feedback from the demo.

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# **I. INTRODUCTION**

## **A. RESEARCH DOMAIN**

The ultimate goal of the training regimen that Helicopter Marine Light Attack (HMLA) pilots go through is to ensure that pilots acquire a high level of expertise in order to effectively support the ground scheme of maneuver during close air support (CAS) operations. Pilots must be able to effectively communicate and make timely decisions in a complex and dynamic environment. One of the performance requirements is that they must maintain a high level of situational awareness; in complex objective areas that can mean the difference between life and death. This is equally important among pilots, as well as Joint Terminal Attack Controllers/Forward Air Controllers (JTACs/FACs). Standardized procedures and communication are foundational, but there is little substitute for experience and training in the real aircraft. Inexperienced pilots often times have difficulty with the situations in which they have to manage and prioritize multiple tasks: flying the aircraft, operating weapon systems, and conducting CAS procedures during their initial training flights. There are many skills that need to be put to practice at the same time, and for the pilot under instruction (PUI) it may become overwhelming. The complexity of the mission combined with a lack of experience may lead to a decrease in the pilot's situational awareness which, in extreme cases, can result in fatal consequences.

Current training methods rely initially on a ground-school type of approach, followed by training events in the flight simulator, and lastly with flight events in the aircraft. The expected level of proficiency in between the two consecutive methods of training is significant; it is not uncommon that PUIs feel that they are not well prepared for their first CAS flight in the aircraft. It is therefore essential that the time in between training evolutions is optimized to better prepare PUIs for each upcoming phase in the CAS syllabus. This includes devising supplementary forms of training that would serve as a bridge between two training evolutions that are scheduled back-to-back. Current supplementary

training methods include chalk talks, walk-throughs, talk-throughs, chair flying, additional reading assignments, and quizzes. The common denominator for all those approaches is that they support training of one type of skill and task in isolation from other tasks. These methods have varying degrees of effectiveness and are not always standardized or shared among other squadrons or communities. It is imperative that PUIs have the ability to rehearse with tactically relevant and accurate examples of CAS missions on their own time, and in that way better prepare for each phase of the CAS syllabus.

## **B. RESEARCH PROBLEM AND MOTIVATION**

There is a very steep learning curve associated with the CAS syllabus, and PUIs are often overwhelmed during their initial CAS flights. Effectively breaking down the tasks required in CAS operations, and providing PUIs with a way of conducting repetitious training is essential for the effective training of the pilots. The very foundation of that training is the knowledge and skills associated with standardized procedures and communication.

Among military men it is commonplace that interallied and interservice operations inescapably pose grave difficulties in execution. Differences in equipment, in doctrine, in attitude and outlook stemming from contrasting past experience all inhibit and complicate harmonious interaction. Past successes, however, have shown that these difficulties can be overcome where determination is present and effective procedures have been applied by properly trained troops. Experience also shows that armed forces . . . have been slow to hammer out the necessary procedures. Often corrective steps have been achieved only after many failures in battle. In no area of interservice operations has this phenomenon been more pronounced than in the matter of close air support. (Cooling 1990, 535)

CAS doctrine has evolved over the time and the procedures are well published. However, the methods and techniques for CAS training have not evolved as much. As technology advances and training domain is forced to operate under more fiscally constrained budget, a need for alternative training solutions that save resources and provide more effective training results

inevitably increases. The use of simulation-based training is one form of that new training approach. PUIs are expected to study and prepare for CAS simulator and flight events on their own, and the opportunities to rehearse with other more experienced pilots and instructors, while highly desired by PUIs, may be limited. This is often due to other higher level training priorities in the squadron and limited resources (i.e., instructors' availability). The same issue can happen during flight events in the aircraft, where multiple training requirements need to be achieved by other members of the flight. For example, if the PUI is part of a larger flight, such as a section (two-ship) or a division (four-ship), and the training priority is the Section Leader Under Training or Division Leader Under Training. This issue will only get worse with further military budget cuts.

In an increasingly constrained fiscal environment, the opportunities to conduct live CAS in the aircraft will become even more limited. This will put a greater emphasis on the use of simulators. Additionally, it is imperative that PUIs are able to conduct enough repetitions to build the experience base necessary to effectively conduct CAS missions. In line with what Gen Neller (2016) said in his CMC Frago, this can be “enabled by technology, we will increase the amount of training each unit can accomplish—to ‘increase the reps’ in mentally and physically stressing environments for all elements of the MAGTF before they do so on the battlefield” (8). These “reps,” or repetitions, are essential in preparing a PUI for each phase of the CAS syllabus; they can be done while conducting rehearsals, during full motion simulator events or events in a live aircraft. Each phase of training must be tailored to allow trainees to get the most value out of the follow-on training events. Since PUIs are expected to conduct a myriad of tasks that are both internal and external to the aircraft while, at the same time, conducting a CAS mission, it is inevitable that training approach will rely on the existence of several part-task trainers.

## **C. RESEARCH QUESTIONS**

The foundation of the thesis is based on the following research questions:

- Is there a training gap between the required academic courseware and the simulator/flight events in the close air support syllabus for Marine Light Attack Helicopter (HMLA) Pilots?
- What type of supplemental academic tools and approaches are instructors using in training of USMC pilots for close air support operations?
- What is the feasibility of developing a prototype virtual reality (VR) system that could support training of close air support procedures and communications?

## **D. SCOPE**

The scope of this thesis is to investigate current supplemental techniques used by HMLA squadrons to better prepare PUIs for the CAS training syllabus. The work also includes a design and implementation of a portable training solution that uses virtual environments technology to support of Marine Light Attack Helicopter CAS training. Basic feasibility tests are included, however conducting training effectiveness study is outside of the scope of this effort. Additionally, this research seeks to utilize existing pilot's and squadron's devices and training solutions in conjunction with other commercial off the shelf (COTS) technology, all with a goal of creating a foundation for a cohesive family of training solutions.

## **E. APPROACH**

This study analyzes current training methods used within HMLA communities and seeks an alternative portable COTS training solution. A task analysis of the CAS mission and analysis of current CAS training in HMLA communities was conducted, followed by a survey with MAWTS-IPs, WTIs, and PUIs to determine the perception of the current trends and gaps in the CAS training syllabus within the HMLA community. Once the results were analyzed the system requirements and design of the new training system was conducted.



This information, combined with existing information about how to best design a part-task trainer, was utilized to build a prototype system. This prototype was then demoed to a group of HMLA pilots in a feasibility test to gain informal feedback on the system capability.

## **F. THESIS STRUCTURE**

The following chapters summarized below:

- Chapter II describes the history of CAS and the current training syllabus used by HMLA pilots during the CAS stage of training.
- Chapter III describes the concept of using a family of training solutions to enhance current training methods.
- Chapter IV provides a review of virtual reality (VR)/virtual environment (VE) and part-task trainers currently used in military training.
- Chapter V details the task analysis for conducting CAS.
- Chapter VI presents the results of the online survey that was executed with the participation of IPs and PUIs within the HMLA community.
- Chapter VII describes the process of developing a prototype trainer.
- Chapter VIII details the elements of feasibility study and user feedback on the system.
- Chapter IX includes a summary of the conclusions and discusses future work.

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## **II. BACKGROUND**

### **A. INTRODUCTION**

Close air support (CAS) is a highly dynamic mission set that often requires from the pilots to make life-or-death decisions. Learning this mission set is especially challenging for a new PUI who typically has limited experience with operations conducted in complex objective areas. In order to gradually build PUI's skills to the required performance standard, current training practice utilizes a crawl, walk, run approach. Each of those phases exposes a trainee to a progressively more advanced set of training solutions and scenarios. Additionally, the training that a PUI conducts between the "crawl" and "walk" phase and between the "walk" and "run" phase needs to be optimized to ensure the most training value is derived from the "walk" and "run" phases (i.e., events in the full motion flight simulator and live aircraft, respectively).

### **B. PROBLEM SPACE**

Joint Publication 3-09.3 defines CAS as "air action by fixed-wing (FW) and rotary-wing (RW) aircraft against hostile targets that are in close proximity to friendly forces and requires detailed integration of each air mission with the fire and movement of those forces" (Chairman of the Joint Chiefs of Staff [CJCS] 2014, I-1). The term "close" refers to the situation and the "detailed integration" that is required, and it does not refer to a specific distance. The detailed integration that is required, relies on clear and effective communication between the pilots and JTACs.

The importance of being able to communicate quickly and clearly on the battle field is critical. The reason that the communications and procedures outlined in doctrinal publications are consistent with joint publications is to ensure that all players on the battle field have a common language with repeatable and predictable procedures. The increased effectiveness in communication leads to an increased effectiveness on the battlefield. It is also commonly understood

among the participants of CAS operations that if the players do not adhere to this common language and predictable procedures, the situation may lead to confusion and result in enemy getting away or worse yet, incidents of fratricide.

This standardization of communications and procedures provides a much needed foundation for this type of operation, but it still requires pilots and JTACS to be well trained and proficient in the execution of the CAS mission set. The Joint Publication 3-09.3 goes on to say that “units must conduct regular joint training and rehearsals that simulate situations joint forces will encounter in the operational environment, in order to develop the skill sets and familiarity required for success (CJCS 2014, I-10).” In order to provide units with training solutions that fully simulate what they might encounter and experience while conducting mission in the operational environment, a considerable amount of time, money, and resources are required. And while this may present the training audience with an ideal experience, it is not feasible to provide all aircrew with this type of training experience every time they train due to limited amount of resources. Additionally, since CAS operations require participation of an entire team, if a particular individual is not adequately prepared for a training evolution, the overall training value for all participants involved may be diminished. Also, the number of repetitions needed to develop the required level of proficiency for a pilot is significant, and is likely to vary between individuals.

While a pilot may desire to get more repetitions in a simulated CAS environment, it is unlikely that a squadron can afford the time and resources to give the pilot that opportunity. The pilot training officer (PTO) in a squadron has a limited amount of available aircraft, flight time, range time, ordinance, JTACS/FACs, and other required resources. He must balance these resources with the required number of initial training events and proficiency training events he is responsible for scheduling. One way of providing the pilots with an opportunity to tailor the number of repetitions to their individual skill level and their individual training needs, is to develop a system that would allow pilots to train that particular skill set by themselves or with others via a network. This thesis aims to

develop such a system, a part task trainer focused on one subset of CAS skills, and allow IPs to build scenarios that could be utilized in repeated fashion by PUIs as many times as they deem needed. Once the scenarios are built they can be shared among different IPs and squadrons. This would automatically provide all PUIs with a greater variety of scenarios available for their training, and allow IPs to modify and reuse existing scenario to support needed training requirements as well as new tactics, techniques, and procedures (TTPs).

### **C. CURRENT CAS TRAINING**

The *Marine Corps Training and Readiness* manual for AH-1W pilots establishes initial training and currency requirements. The current training approach acknowledges a “crawl, walk, run” stages. Initially, the training focuses on understanding “discussion items” that a PUI must be able to discuss during the flight brief; this is typically done by completing the required readings, lectures, and “chalk talks,” the “crawl” phase. That training is followed by one event in a Full Motion Flight Simulator—the “walk” phase. Lastly, they move to a set of final events that are conducted in the actual aircraft, the “run” phase.

The initial ground/academic training portion of the close air support stage falls under the offensive air support (OAS) stage. The OAS stage includes the following self-paced readings:

- NTTP 3–22.3-AH1, Chapters 1, 8
- MAWTS-1 Night Vision Device Manual, Chapter 12
- MCWP 3–23 Offensive Air Support
- MCWP 3–23.2 Deep Air Support
- MCRP 3–23C Strike Coordination and Reconnaissance
- JP 3-09.3 close air support
- MCRP 3–16.6A JFIRE

Additionally, prior to initiation of this stage, they are requested to take a series of lectures presented in Figure 1.

Figure 1. OAS Lecture Requirements. Source: Department of the Navy (2014).

CAS/AR/AI/SCAR		
ACAD-3030	RW OAS*	ASD Common Courseware
ACAD-3031	(S) Urban CAS*	(S) ASD Common Courseware
ACAD-3032	Close Air Support	ASD Common Courseware
ACAD-3033	CAS Execution*	ASD Common Courseware
ACAD-3034	(S) RW Weaponneering	(S) AH-1 Specific Courseware
ACAD-3035	HMLA AR and SCAR TTPs	(S) AH-1 Specific Courseware
* Indicates classes that should be presented to all pilots annually.		

Once the PUI has completed the required readings and lectures, he is required to complete the following set of chalk talks:

- CAS Discussion and Walk-through Demonstration
- H-1 close air support Tactics, Techniques, and Procedures
- AH-1 close air support Tactics

It should be noted that the AH-1 Course Catalog says, “Unless otherwise noted (e.g. IUT [Instructor Under Training] led), chalk talks are intended to be led by a squadron instructor” (Department of the Navy 2014, 1–3). Upon completion of the chalk talks, the PUI then proceeds to the simulator and flight events.

Figure 2 shows the list of required flight and simulator events for the CAS stage in the 2014 AH-1W T&R manual. The first event, 3300 “Intro to CAS” is a simulator event. The next four events, 3301, 3302, 3302, and 3304, are CAS events conducted in the aircraft, while the 2705R is an event that focuses on ordinance delivery procedures under low light level (LLL) conditions. The learning curve is very steep for a junior aviator. Up to this phase he (she) has primarily been focused on learning aircraft systems and procedures that are required for flying and employing weapon systems.

Figure 2. AH-1 CAS Proficiency Table. Source: Department of the Navy (2014).

AH-1W ATTAIN AND MAINTAIN PROFICIENCY TABLE						
MISSION SKILLS (3000 Phase)						
SKILL	STAGE	T&R DESCRIPTION	ATTAIN PROFICIENCY			MAINTAIN PROFICIENCY
			BASIC	REFRESHER	SERIES CONV	
CAS	SCAS	Intro CAS	3300		3300	
	CAS	Intro Day CAS	3301R	3301R	3301R	3301R
	CAS	Intro NVD CAS HLL	3302			
	CAS	Intro NVD CAS LLL	3303R	3303R	3303R	3303R
	CAS	Intro Urban CAS	3304R	3304R		3304R
	ANSQ	Rev NVD LLL Ord Del	2705R	2705R	2705R	2705R

While the tasks required in the CAS mission are dynamic and demanding, some of the initial difficulty arises from the fact that PUIs do not have solid understanding for what the flight in an actual aircraft will be like. For example, a PUI may have a good conceptual grasp of what the Execution Template is and how it is used, however it may be difficult for the PUI to prioritize tasks when he is faced with the real environment.

Each pilot across all squadrons is held to the same standard as prescribed in the Training and Readiness (T&R) manual. If they want the instructor to sign off on their completion of one training event, they must demonstrate a level of understanding commensurate with the performance standards outlined in the T&R. While the T&R manual provides the standard of performance and required training events, there is a variety of ways that squadrons and Instructor Pilots can use to conduct ground training and prepare for the mission-specific training flights. For example, a “chalk talk” may be used to help provide a better mental model of what the PUI might expect to see in the actual objective area. The use of “chalk talks” can also help the pilot gain a better understanding of how the communication flow and procedures will actually sound like once in the objective area. In addition to the three required “chalk talks” for the CAS stages, many instructors use “chalk talks” and other similar mission rehearsals to supplement the current training syllabus.

Standardized procedures and communication flows are foundational to the execution phase of close air support. However, it is imperative that PUIs have a solid understanding of the problem schema and get an opportunity to hear what an objective area might sound like during a CAS mission. Additionally, they need the opportunity of having the number of repetitions necessary to operate at a level that allows them to get the maximum possible value out of a live CAS training evolution. The current method of training produces training results, however, we believe that those results would be even better if PUIs would have time and additional training solutions they could use in between the “crawl,” “walk” and “run” phases. If the time on the ground is used to fill the remaining training gaps (solidify a specific skill), that has a potential of resulting with better training value out of each sortie executed later on by PUIs. The task of a CAS part-task trainer, for example, is to conveniently remove some of the aircraft specific tasks like flight control manipulation, sensor employment and weapon employment, and focus on acquisition of targeted set of skills like CAS communications and procedures.

We believe that pilots’ performances in the aircrafts will be increased if they use part task training solution that augments current “chalk-talk” method. That solution is imagined to be a standalone computer-supported training system that utilizes interactive visualization, three dimensional functionalities of virtual environments, and multi-user connectivity via computer network. The same training system could support PUIs training on their own, and it could be used by IPs for one-on-one instruction with scenario based questions designed to serve as talking points for discussions.

#### **D. CHAPTER SUMMARY**

This chapter discussed the basics of the close air support mission, the importance of standardized procedures and quality training for the pilots. The material reviewed current training syllabus and other supplemental training



methods and introduce the format and the benefit that part-task trainer could bring to the training of PUIs.

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### **III. FAMILY OF TRAINING SOLUTIONS**

#### **A. INTRODUCTION**

As with any other training environment, it is important that a new training solution gets effectively integrated into the existing training regimen. In order to do so, the aspects of the interface and supporting technologies need to be designed with existing training systems and training requirements in mind. Usability and compatibility with the rest of the training environment—training systems and best practices—will further increase the systems likelihood of adoption by intended users. Using a family of training solutions approach could help to enhance existing training methods, by making the transition between systems or phases of training easier for the user.

#### **B. INTEGRATION WITH EXISTING TRAINING SYSTEMS**

In order to optimize the training used in support of the “crawl, walk, and run” approach, it is important that all training solutions get well aligned and integrated with the existing phases of training. This integration will help bridge potential gaps that may exist between different phases of training, while also minimizing the amount of time the user has to spend learning how to use the new (next) training system.

We identified four categories of attributes that should ideally be observed when forming a family of training solutions. The first attribute concerns the look and feel of the system. The second is the ability of the training environment to support all phases, training objectives and projected levels of difficulty, and still allow for the most efficient transition between separate phases of training. The third attribute addresses the ease of learning of each training solution; familiarity with capabilities, and interactive modalities of one system should provide a good basis for what another (next in training pipeline) system offers. Lastly, the fourth attribute is a compatibility of the training solution with other systems that may exist in the overall training environment. For example, it may be possible to

incorporate information from other existing systems that may create new or more efficient ways to utilize the system for training. These attributes are directly related to the Human Factors portion of the Training-Center Diffusion of Innovation Model (TC-DIM) that Sadagic and Yates extended from the Rogers Diffusion of Innovation model (Rogers 1983), TC-DIM model also includes, “usability of human-computer interfaces, level of realism (as perceived by the user), sensory fidelity and how it maps to training objectives, user acceptance of technology, and user attitudes towards technology” (Sadagic and Yates 2015, 4).

### **1. Look and Feel**

The system should provide the user with interfaces that are similar to what they currently train with; in case of training of pilots those would be interfaces in the flight simulator and in the aircraft. For example, similarity in visual design between different training solutions will likely enhance the feeling of their connectedness and mutual support. Even if the system is a part-task trainer, the interface it uses can be designed to provide the user with a sense of familiarity and similarity with other training systems they have used or will use during the conduct of the entire stage of training. For example, if a part-task trainer was to be added to the current set of training solutions, if possible (and justifiable) its interface design should be created to closely resemble other existing training systems.

### **2. Bridging Training Phases**

The system needs to have ability to effectively transition between the phases of existing training regimen. It may be that current systems utilize a building block approach to developing a particular skill set in the training approach. However, it is possible that the proficiency required between the systems is such that users are not able to initially take advantage of the next phase of training because the gap in their skill set is too large. This may not be the case for every user, however, by inserting a training system that is readily available to users in between these phases, it may allow them to get more

prepared for the next phase of training. Additionally, the same training system may be used for multiple purposes and fill multiple training gaps. This could ultimately result in a more proficient trainee at the end. In case of training for CAS operations, for example, instructors could use the same system at multiple phases of the CAS training stage by just changing the level of complexity of the scenarios. The system could be used early on to prepare PUIs for the first simulator event which might consist of a relatively straightforward CAS missions, or it be used to prepare PUIs for their last CAS flight which may be a more dynamic event.

### **3. Ease of Learning**

The level of difficulty while operating a training system will inherently be minimized by building a system that has the same “look and feel” of flight simulator and the aircraft. Smart interface the design should minimize the amount of initial learning required to operate that system whenever possible. For example, if the same interactive modalities and segments of user interface are used in multiple training solutions (phases) that will very likely reduce the learning curve; the system will not be as difficult to learn and as such it will make intended users more willing to adopt them.

### **4. Compatibility with Existing Systems**

By creating a system that is compatible with existing hardware and software, training force may be able to incorporate information and data streams from other systems, and create new or more efficient ways of utilizing current system in their training. For example, if the training solution could import data save in Keyhole Markup Language (KML) files generated with another training or operational system, it could provide an instructor with a multitude of new options and minimize a need to re-create the same data sets. KML is used to export overlays that can be created in GoogleEarth or in kinetic integrated low-cost software integrated tactical combat handheld (KILSWITCH). It is of note that KILSWITCH platform is currently used in many squadrons to input mission

planning data. This data set often includes routes, Holding Areas (HAs), Battle Positions (BPs), enemy and friendly locations, and other control measures. Since this information is already being created, it would reduce instructors' time to create new scenarios; it would allow them to tap into a large amount of existing overlays of real-life missions that have already been created in the past. This would also allow instructors to use software that they may already be comfortable using, such as GoogleEarth. In that case, an overlay file could simply be created and imported into the system, and potentially shared with other instructors to serve as a baseline for their scenario development.

Another way of making the training system compatible with existing training solutions would be to provide a networked option of that system and use Distributed Interactive Simulation (DIS) standard. This would allow the system to tie into many other existing simulations across similar domains, potentially resulting in more realistic scenarios. For example, in case of training for CAS operations a scenario used by a PUI could include combat vehicles controlled by actual vehicle operators in a separate combat vehicle simulator.

The use of full motion flight simulators is also limited due to the number of pilots requiring simulator training and the few number of simulators available. It might be possible that simulator event data could be saved and exported to a file. This file could then serve as the basis for a scenario for which users could go back and replay the event or train with as many times as they desired. Additionally, the instructors could use it to build their solutions and help prepare other PUIs for similar training evolutions.

The system could also take advantage of existing hardware that pilots currently have, as well as other commercial off-the-shelf (COTS) systems. This has a potential of positively affecting affordability and adoption for multiple reasons. For example, pilots are more likely to utilize the system if it is on a piece of gear they already have and use. Some squadrons are already issuing tablets or electronic kneeboards (EKB) that, in turn, could serve as hardware platforms for the training system. Similarly, if the system is designed as a software solution

that can run on a COTS platform possibly running an Android based operating system, it is likely to be more affordable—a new dedicated hardware platform would not necessarily need to be acquired.

### **C. CHAPTER SUMMARY**

This chapter discusses how a family of training solutions could be formed and used to enhance current training methods. Ensuring the new proposed system is well integrated with existing training methods, provides the user with a similar look and feel, and it is easy to learn while making the transition between existing phases of training smoother. The concept of family of training solutions could also serve as the framework for the development of an entirely new training approach.

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## **IV. VIRTUAL ENVIRONMENTS**

When looking at how virtual environments (VEs) might be used for training applications, it is important to examine the pros and cons of different VE characteristics and phenomena associated with VEs. Viewing perspectives, presence, and fidelity of information presented to the user are examples of characteristics that impact the user's spatial recognition, retention, and situational awareness when they use VE for training. It is therefore important that these characteristics are well understood during the design and production of VE system if the same is to be the used for training.

### **A. VIEWING PERSPECTIVE**

The position from which the viewer interacts with a virtual environment determines if they are viewing from a first-person perspective (Figure 3 – view of the scene as seen from the pilot's eyes) or a third-person perspective (Figure 4 – view of the scene as seen from outside of the pilot's cockpit.)

Figure 3. First-Person Perspective

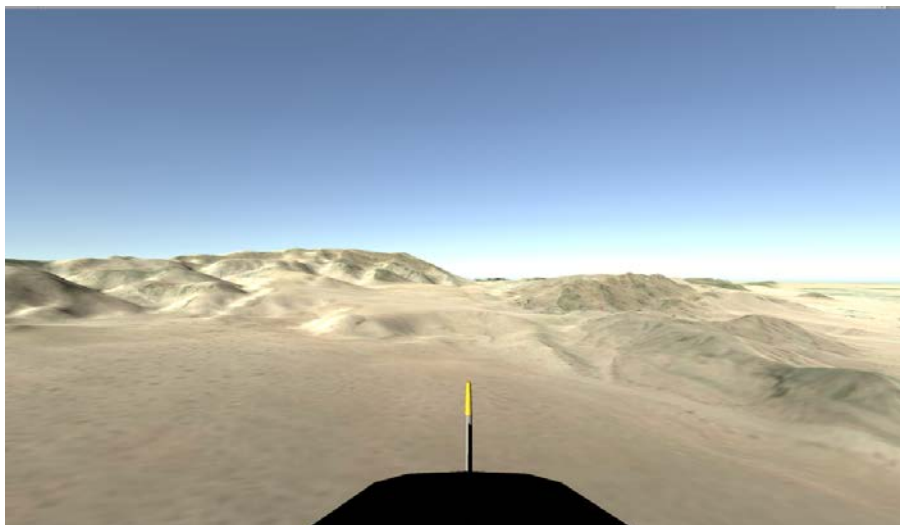
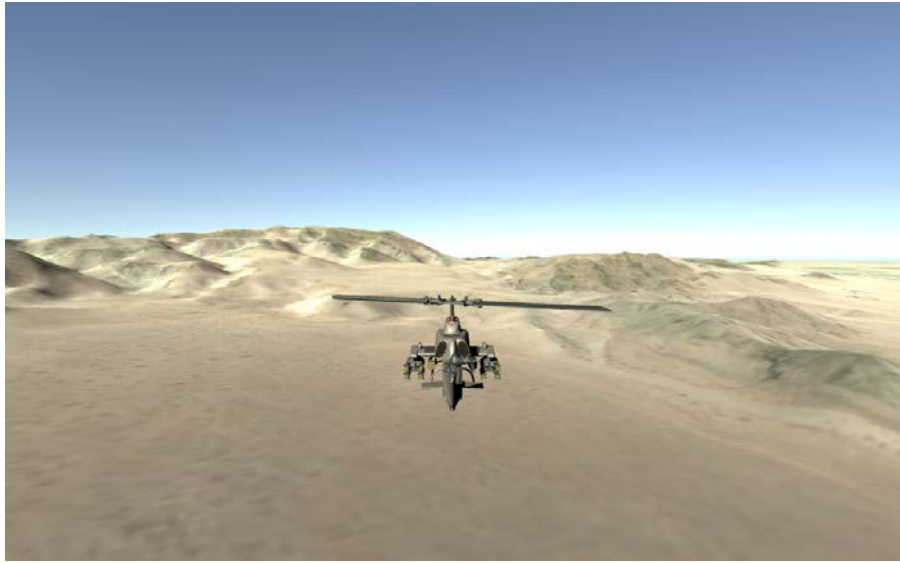


Figure 4. Third-Person Perspective



The benefits of a third-person vs first-person perspective in virtual environments have been examined in several studies. The results suggested that the gamers preferred viewing the scene from a third-person perspective when moving (navigating) through 3D space, while actions which require hand manipulation or precision tasks, first-person perspective was desired (Salamin et al. 2006). The authors wanted to verify if these same benefits existed in virtual and augmented reality simulations. In order to compare the situations with third-person perspective and a first-person perspective, they conducted an experiment in which 8 people ranging from 23 to 28 years old, were tested for preference in type of perspective. The experiment included five randomly chosen tasks: walking approximately 50 meters through a curved hallway with obstacles, opening a door, placing a ball inside a cup, and lastly rolling a ball back and forth with their feet followed by the same task using only their hands (Salamin et al. 2006). The analysis of study results collected through the questionnaires suggested that first-person perspective scored between 3 and 7; while third-person perspective scored between 6 and 9 (study used a scale from 0 to 10—0 being the worst and 10 being the best). They also found that “the main advantages of the first-person perspective were the smaller adaptation time and

the possibility to use more common gesture to catch a close object. But in most of the situations, the users widely prefer the third-person perspective, e.g., walking, evaluating the distance, opening a door, playing with a ball (with hands and feet).” The same study generated another interesting result: due to a larger field of view, the users of third-person perspective generally were better able to evaluate distances and assess the trajectory of moving objects. This is an important finding as it applies to the use of virtual environments in military training applications. While it is desirable that users maintain a level of presence that would provide best support for skill acquisition, it is also important that the tasks associated with the training objectives could be executed effectively and efficiently. In order to do this, it may be necessary to allow users to change (control) their viewing perspectives throughout the training evolution.

In addition to collecting self-reported data sets, another group of authors sought to conduct similar experiment that collected objective data set in form of electroencephalogram (EEG) data (Tadi et al. 2010). They used this type of data to compare user performances in two conditions—a third-person perspective (3PP), and a first-person perspective (1PP). Their goal was to gain better understanding on how the brain relates the objects with their environment in the real world and in VEs. The analysis of EEG data collected from 16 participants, the researchers found two points where brain activity was significantly different between 3PP and 1PP in both duration and strength of brain activity. They also found that exposure to different perspectives can positively or negatively affect user’s performance when they switch between different viewing perspectives. It is likely that additional studies would need to be conducted on our system to determine the benefit of using a 1PP versus a 3PP.

The analysis of the type of tasks that users would be requested to execute in our training simulation (details presented in Chapter V), suggested that a third-person viewing perspective would be the best choice for our VE training solution.

## **B. MENTAL MODEL**

The use of VEs was also examined in the light of helping the users build mental models. Bowman et al. suggest that virtual environments could be used to help with education (Bowman et al. 1999). In that article, the authors discuss the importance of direct experience and how it relates to education. They comment that it could be argued that “experience is the best teacher,” but also suggest that experience “can take a student only part of the way to learning and understanding a subject” (Bowman et al. 1999, 317). The authors used an example of a high school students not understanding light refraction, which they may have seen many times, until they study it in a physics class. They also discuss how relying exclusively on experiences for learning can be dangerous because it is possible for one to construct mental models which are incorrect due to a logical conclusion that was made from the experiential data (Bowman et al. 1999). This idea is very important, as it can apply to many military applications. In order to make the most benefit from VE training system, prior to using that system, students typically take a number of classes that help them acquire clear understanding about the phenomena and tasks they will be presented with in training system that, by and large, provide them with experiential element of that phenomenon or task.

Bowman et al. also discuss the importance of scientific simulations, and how it can be used to display abstract objects that may normally be difficult or impossible to simulate without leveraging approaches adopted in scientific visualization field. A “database visualizations” can take a dataset and “organize it into an understandable visual representation that can be navigated and accessed by the user” (Bowman et al. 1999, 318). The authors categorize these types of visualizations as being of the “perceptual” or “geometric” versus the “symbolic” form, in which speech or text may be used; both “perceptual” and “symbolic” forms can be used together to create an “information-rich” VE (Bowman et al. 1999).

### C. PRESENCE AND VIEWING PERSPECTIVE

The authors Witmer and Singer define *presence* as “the subjective experience of being in one place or environment, even when one is physically situated in another” (1998, 225). *Immersion* is “considered a description of a technology and describes the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant” (Slater and Wilbur 1997, 603).

The sense of presence was studied in many application domains, including training domain. In an article by Stevens and Kincaid, the authors describe an experiment that looked at the relationship of soldiers’ performance in an aerial gunnery simulation and their sense of presence in the same simulation (Stevens and Kincaid 2015). The data analysis determined a moderate, significant correlation between performance and sense of presence. The study suggested that it may be possible to increase user’s task performance if the trainee has better conditions for experiencing increased (higher) level of presence in that training simulation.

The ultimate goal of any training solution is provide best conditions for effective and efficient knowledge and skill acquisition. If higher level of presence has a potential to provide better user performance, it is advisable to look at how different VE characteristics, including user’s viewing perspective, contribute to his (her) sense of presence. Additionally, user performance may also be affected by how the person “represents a memory of some event, referred to as *perceptual position*” (Slater and Usoh 1993, 223). Slater and Usoh describe *first*, *second*, and, *third* position as the different ways that a person sees events internally from memory. First position, meaning where the person “might internally see the event from the same perspective that they had at the time, as if they were there again, seeing it from a personal perspective” (Slater and Usoh 1993, 223). Second position means the event is represented the way that a person might “see themselves” from another person’s point of view (Slater and Usoh 1993, 223). Third position being like second position, but the point of view being from “an

abstract, nonpersonal point of view” (Slater and Usoh 1993, 223). The result of this study concludes that people may experience a higher sense of presence if they see events from the same perspective they have as a memory of the event.

Another study looked more closely at immersion phenomenon in “digital games” (Denisova and Cairns 2015); the interpretation of immersion in this paper was “a state of complete involvement with a digital game.” In the study, 40 participants played a Playstation 3 video game that had the ability to switch between first and third-person perspective; the study used five point Likert scale questionnaire to measure their level of presence during game play. They found that the users who played the role-playing game from first-person viewing perspective reported higher levels of immersion than the users who used a third-person viewing perspective. While this study was conducted using a game, the same conclusion might hold true for certain training or learning simulations where users control a character throughout their experience with virtual environment.

#### **D. DECISION MAKING AND VIEWING PERSPECTIVE**

Viewing perspective has also been looked at with respect to users’ decision making. A study conducted by Mann et al. investigated how viewing perspective influenced decision-making of football players in Australia (Mann et al. 2009). The authors suggested that the expert advantage was reduced as the similarity to the environment in which they normally performed got reduced (Mann et al. 2009). This reduction in advantage seems to be caused by the fact that the expert is not provided with the same amount of information from the environment that he typically is used to. However, the authors found that if the viewing perspective provided new information relevant to the tactical situation that the expert did not have when they gained their expertise, it was possible that the perspective may have enhanced their decision-making ability. This is important consideration for design of our system—the goal is to ensure that enough information is provided to the trainees (users) and from the right viewing perspective so that the trainees can build their knowledgebase in a way they can

relate to when they conduct CAS missions in the flight simulator or in actual aircraft.

## **E. CHAPTER SUMMARY**

This chapter discusses how various characteristics of VEs could impact the user's ability to train effectively. Viewing perspective, presence, and the information presented to the user can influence the mental model that users develop and relate their experiences to. A third-person perspective was determined to be the most appropriate for our system since the nature of the task to be trained was more external than internal to the aircraft. An additional study would need to be conducted to compare 3PP and 1PP versions of the trainer to determine specific advantages and disadvantages of the two with respect to user performance in the system.

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## **V. TASK ANALYSIS**

### **A. INTRODUCTION**

The close air support mission for pilots in an HMLA requires multiple participants to conduct tasks in unison. Task analysis presented in this chapter focuses specifically on the tasks necessary to conduct the CAS mission for an AH-1W pilot in an HMLA squadron.

Task analysis (TA) provides a comprehensive understanding about the way in which task is performed and the set of steps that constitute that task, their order and relative importance, sensory cues for each step, conditions in which task is performed, characteristics of the individual who performs that task, and the standards of performance expected from that individual. It also outlines the sequence of interactions (communications) that the individual will have with other individuals during the conduct of the task.

A task can be detailed and presented in several ways. The task studied and detailed in this research is presented using listing method (task listing). The results of task analysis were utilized to better inform design of the training prototype. More specifically, determining what the system must be capable of doing in order to meet training requirements that are consistent and expected of PUIs.

### **B. EXECUTION TEMPLATE**

The task analysis presented in this chapter does not include some of the aircraft specific tasks during CAS missions; this was done because our interest was in building a part-task trainer. Some elements of the CAS mission (and consequently some tasks in global CAS mission) were intentionally not supported. The reason for this selective approach was based on the fact that PUIs are often overwhelmed by the amount of tasks they are responsible for when conducting CAS training in the aircraft or simulator. Some of these tasks, such as maneuvering the aircraft, sensor operation, and weapons employment

while crucial to the successful execution of the CAS mission, can often become a PUIs primary focus. This can make it difficult for PUIs to get the main takeaways associated of the CAS procedures that are taught.

In order to ensure that this part task trainer supports the training objectives currently in place for pilots in the CAS stage of training, we utilized the AH-1W Training and Readiness (T&R) Manual (NAVMC 3500.49A 25 Jul 14). Very specifically, the information presented in the “Performance Standards” section was observed, including the discussion items for each flight conducted within 3000 level CAS phase of training. Performance Standards are defined in the T&R manual as “training standards for individual aircrew performance and shall be utilized by the evaluator as a guideline to determine the satisfactory completion of each event. If the aircrew did not successfully attain the performance standards, the training code shall not be logged as a completed flight” (Department of the Navy 2014, 2–17). The performance standards of each event were analyzed and the ones that were aircraft specific (e.g., weapons employment) were removed. The remaining performance standard that was common to all flights in the 3000 CAS phase was: “PUI (Pilot Under Instruction) shall conduct all missions utilizing CAS procedures and communications” (Department of the Navy 2014, 2–88).

The publication Naval Tactics, Techniques, and Procedures for the AH-1 (NTTP 3.22-3 March 2013) was also reviewed; a special emphasis of that review was on section “close air support Execution and Mechanics.” The procedures outlined there and in “Execution Template” from the Joint Publication 3-09.3 close air support, were used to examine communication and procedures that lead up to an attack during a CAS mission. This produced a detailed task list that minimized aircraft specific tasks and outlined the sub-tasks of CAS communication and procedures. This subset represented exactly a set of tasks the aviators needed to practice and avoid a full workload of tasks they would do when flying in the actual aircraft. The details about the resulting subset of those tasks from the previously mentioned publications are listed in Table 1.

Table 1. AH-1W Pilot Task Analysis for CAS Mission

<p>1. <u>PUI shall conduct all missions utilizing CAS procedures and communications (Department of the Navy 2013).</u></p>
<p>a. Initial Check-In at the Contact Point and Movement to Holding Area (HA).</p> <ul style="list-style-type: none"> <li>i. Contact direct air support center (DASC) (mission assignments/updates).</li> <li>ii. Prior to the HA, build situational awareness by monitoring the terminal controller's frequency. Attempt to communicate as early as possible with the terminal controller; however, do not step on missions in progress.</li> <li>iii. If communication cannot be established from the HA, flights must either relay via another asset or move to another position.</li> <li>iv. Once communication is established, aircrews should inform the terminal controller of their location and the status of the flight. Aircrew should expect <b>routing and safety of flight</b> from the terminal controller. <b>Check-in</b> shall be in accordance with Joint Publication 3-09.3, close air support.</li> </ul>
<p>b. Obtain the <b>situation update</b></p> <ul style="list-style-type: none"> <li>i. Utilize the TEFACHR acronym method. <ul style="list-style-type: none"> <li>1. Should receive threat, enemy situation, friendly update, artillery gun target (GTL), clearance authority, hazards, and remarks/restrictions (TEFACHR) update from JTAC/FAC/Air Officer.</li> <li>2. If using single-channel plain text communications, be prepared to encipher through the use of the automated communication electronic operation instruction (ACEOI).</li> </ul> </li> </ul>

(continued on next page)

Table 1 (continued)

<ul style="list-style-type: none"> <li>c. Receive the <b>game plan, CAS Brief, Remarks/Restrictions</b>. <ul style="list-style-type: none"> <li>i. After situation update, expect either to copy a gameplan/mission brief from the terminal controller or be directed to hold.</li> <li>ii. Receive game plan. (a concise and situational awareness enhancing tool to inform all players of the flow of the following attack. <ul style="list-style-type: none"> <li>1. Expect it in the format of Type, Method, Ordnance/Effect, and Interval.</li> </ul> </li> <li>iii. Receive 9-Line or 5-Line (CAS Brief). <ul style="list-style-type: none"> <li>1. Expect the 9-Line and 5-Line briefing formats per the Joint Application of Firepower (JFIRE) and tactical pocket guide (TPG).</li> <li>2. Pilots verify target locations and target area geometry based on the BP, heading, distance, and assigned target-grid relationships. <ul style="list-style-type: none"> <li>a. After receiving the brief, plot the target and check the distance and heading; if they do not match, be sure to request clarification.</li> <li>b. (If wingman) Acknowledge receipt of the CAS brief on the intraflight net prior to the flight leader acknowledging receipt on the fires net.</li> </ul> </li> </ul> </li> <li>iv. Conduct <b>Readbacks</b>. <ul style="list-style-type: none"> <li>a. Clarify any elements or mission specifics that are not clear.</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>d. Conduct <b>Target Correlation</b> (may not be required, e.g., bomb on coordinate). <ul style="list-style-type: none"> <li>i. A talk-on may be given by the terminal controller to aid CAS aircraft in locating and attacking the correct target. <ul style="list-style-type: none"> <li>1. Typically, the controller will describe the target area from large to small features.</li> <li>2. It is helpful to the controller for the aircrew to assist by reporting what they actually see during the brief.</li> <li>3. If the dialog is not running smoothly, inform the controller of what is seen. For example, "Venom 51, contact the large water tower 3 kilometers south of the 3-way road intersection."</li> </ul> </li> </ul> </li> </ul>
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(continued on next page)

Table 1 (continued)

<ul style="list-style-type: none"><li>e. Analysis of the Brief / TOT establishment.<ul style="list-style-type: none"><li>i. Check the time compare with TOT.</li><li>ii. Maintain SA with respect to time.<ul style="list-style-type: none"><li>1. Know how long it will take to get from the HA to the BP or firing point (FP).</li><li>2. Factor in the time of flight of the selected ordnance.</li><li>3. Ensure the briefed information is plotted and checked.</li></ul></li></ul></li></ul>
<ul style="list-style-type: none"><li>f. Conduct the attack.</li><li>g. Assess effects. BPT to execute re-attacks or get new game plan/ CAS brief</li><li>h. Battle damage assessment (BDA)</li><li>i. Routing/safety of flight</li></ul>

## **C. CHAPTER SUMMARY**

This chapter provides details of the subtasks that the prototype training system would need to support if it is to be used as a part-task trainer for close air support. As commented before, the elements of larger CAS mission that were at the center of attention were communication and procedures that had to be followed during CAS mission.

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## **VI. USER STUDY: SURVEY OF CURRENT STATE OF CAS TRAINING AND USER ATTITUDES**

### **A. INTRODUCTION**

Before a new prototype training system was designed it was important to assess the users' perception of current training methods used in the CAS stage. A user study was designed to collect a diverse data set from both IPs and PUIs; the type of data collection used in this study was online survey. This study also collected information about features and design aspects that prospective users might desire in a part-task trainer (both trainees and instructors). Once compiled, survey data set was analyzed and used to better inform the design and development of the prototype part-task trainer.

### **B. METHODOLOGY**

HMLA pilots are responsible for a multitude of mission sets; the study that supported this research was scoped to focus only on the CAS stage of their training. The online survey included the questions that were designed to help identify perceived issues or gaps in the current training syllabus as well as the methods currently used to overcome them. The use of an online survey was determined to be the most appropriate for this study due to the diverse geographic locations where the units resided. Two online surveys were designed, one for the pilots (PUIs) and one for the instructors (IPs); due to the nature of information being collected they both required a review and approval from the Naval Postgraduate School's Institutional Review Board (IRB).

The IP survey was designed for the Subject Matter Experts (SMEs) within the HMLA community. Those SMEs consisted of Weapons and Tactics Instructors at each operational squadron, and Marine Aviation Weapons and Tactics Squadron – 1 (MAWTS-1) Instructor Pilots (the IPs that train WTIs). The second survey was designed for the pilots under instruction that have not attained any instructor level qualifications; they were primarily PUIs who are still

in the CAS stage of training or have recently completed the stage. It was important that information was gathered from both IPs and PUIs—each community had different concerns and understanding of training priorities. It was also ensured that surveys for each group have several questions that were exactly the same; this allowed comparing the perceptions of two groups of users that have different roles in training event—one group being the trainees and another group being the instructors. This also helped identify the issues and interface design recommendations that were not necessarily in full agreement. There was also a possibility that the IPs may have felt that the instruction did not have any gaps (as they were predominantly providers of that instruction), while the PUIs may have still felt unprepared for certain levels of training.

As a part of IRB procedure before the online survey was administered an approval was sought and gained from the commands of the units that were to be surveyed. The links to the surveys were then sent directly to each individual.

## **C. APPARATUS**

LimeSurvey was used to facilitate the full conduct of the online survey: survey questionnaire was built using LimeSurvey tool, and the Naval Postgraduate School's server was used to store the survey data.

## **D. STUDY RESULTS AND DISCUSSION**

### **1. Analysis of Demographic Data**

The survey link was sent out to 115 PUIs and 59 IPs. A total of 31 PUIs and 31 IPs responded to the survey.

Table 2 and Figure 5 show the break down by billet for the IP survey responses, while Table 3 and Figure 6 show what geographic location the IPs have conducted the majority of their time instructing. The number of Hawaii responses was lower due to the fact that there was only one squadron there, and they have only been there for a few years. The ratio of Squadron WTIs to



MAWTS IPs is what would be expected since there are relatively few MAWTS IPs when the two are compared.

Table 2. IP Billets

	MAWTS IP	Squadron WTI	Not responded	TOTAL
#	9	22	0	31
% of Total (= % of responses)	29.03	70.97	0.00	100.00

Figure 5. IP Billets

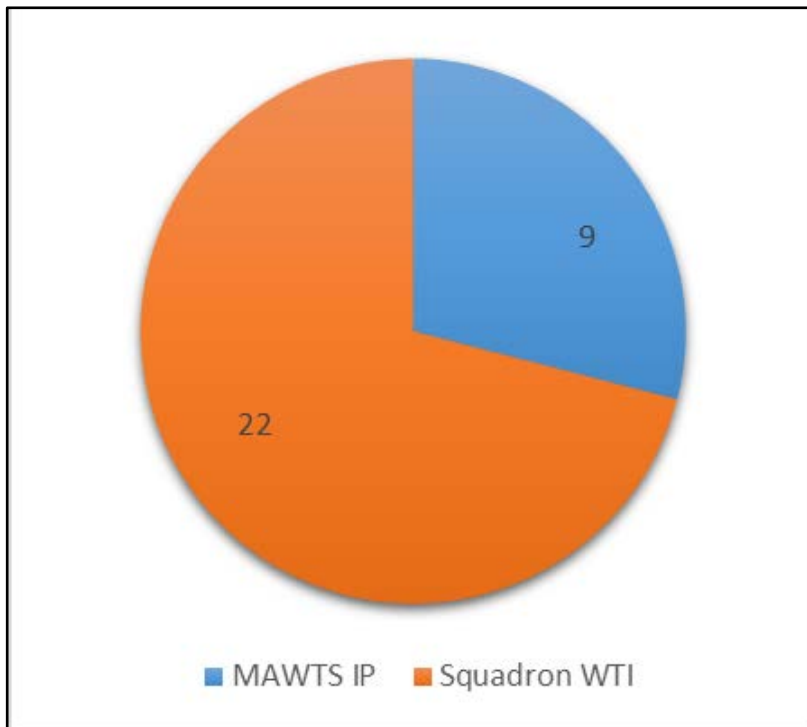
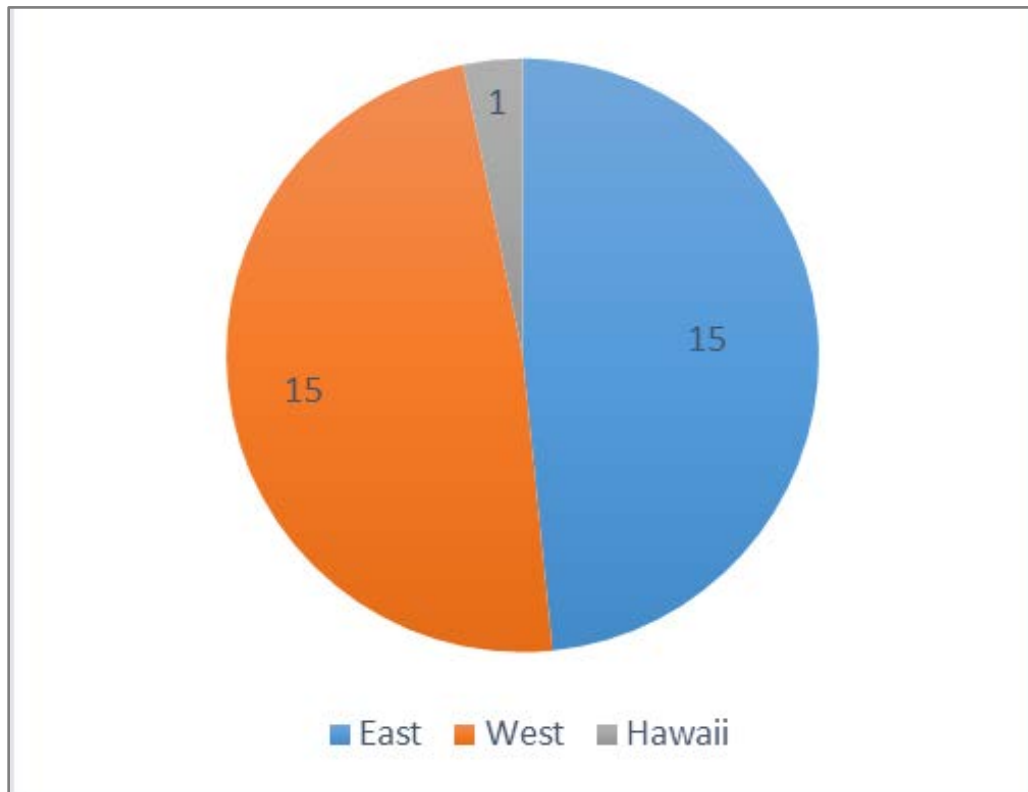


Table 3. IP Geographic Location

	East Coast	West Coast	Hawaii	Not responded	TOTAL
#	15	15	1	0	31
% of Total (= % of responses)	48.38	48.39	3.22	0.00	100.00

Figure 6. IP Geographic Location



A total of 31 PUIs responded to the survey. Data presented in Table 4 and Figure 7 show a break down by the number of PUIs that have completed their first flight event in the CAS stage, and data in Table 5 and Figure 8 shows which geographic location that the PUIs have conducted the majority of their training at.

Table 4. PUI Stage, First CAS Flight Completed

	MAWTS PUI	Squadron WTI	Not responded	TOTAL
#	24	7	0	31
% of Total (= % of responses)	77.42	22.58	0.00	100.00

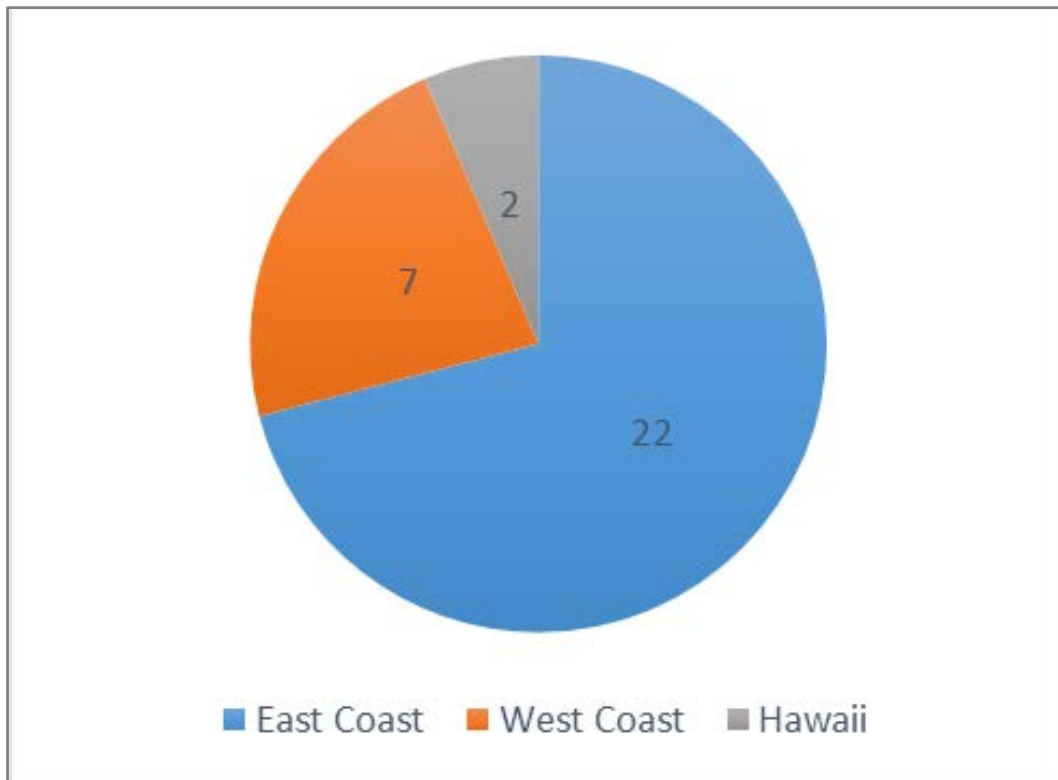
Figure 7. PUI Stage, First CAS Flight



Table 5. PUI Geographic Location

	East Coast	West Coast	Hawaii	Not responded	TOTAL
#	22	7	2	0	31
% of Total (= % of responses)	70.97	22.58	6.45	0.00	100.00

Figure 8. PUI Geographic Location



## 2. Training Practices

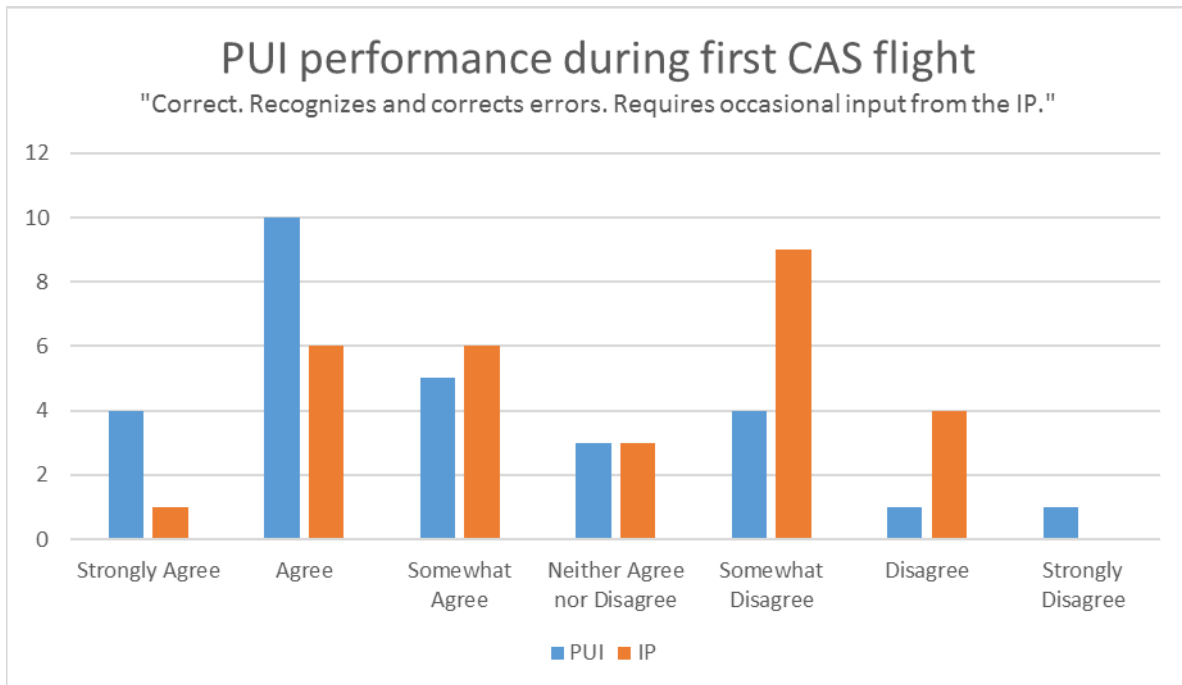
This section discusses the analysis of a set of questions that pertained to the current training practices in HMLA squadrons. PUIs and IPs were both asked the following question: “During the first flight event in the CAS stage, most PUIs are able to conduct ‘all missions utilizing CAS procedures and communications’

and at a level commensurate with a '2' on an Aviation Tracking Form ('Correct. Recognizes and corrects errors. Requires occasional input from the IP.')" to determine if PUIs and IPs felt the same about PUI performance during early stage flights. Based off of the survey results shown in Table 6 and Figure 9, PUIs seem to "agree" that their ability conduct CAS procedures and communications were "Correct. Recognizes and corrects errors. Requires occasional input from the IP." While, IPs were more spread out, the category with the highest number of responses was "Somewhat Disagree."

Table 6. PUI Performance on First CAS Flight

During the first flight event in the CAS stage, most PUIs are able to conduct "all missions utilizing CAS procedures and communications" and at a level comensurate with a "2" on a Aviation Tracking Form ("Correct. Recognizes and corrects errors. Requires occasional input from the IP.")		
	PUI	IP
# of Strongly Agree	4	1
# of Agree	10	6
# of Somewhat Agree	5	6
# of Neither Agree nor Disagree	3	3
# of Somewhat Disagree	4	9
# of Disagree	1	4
# of Strongly Disagree	1	0
# of Did not respond	1	0

Figure 9. PUI Performance on First CAS Flight



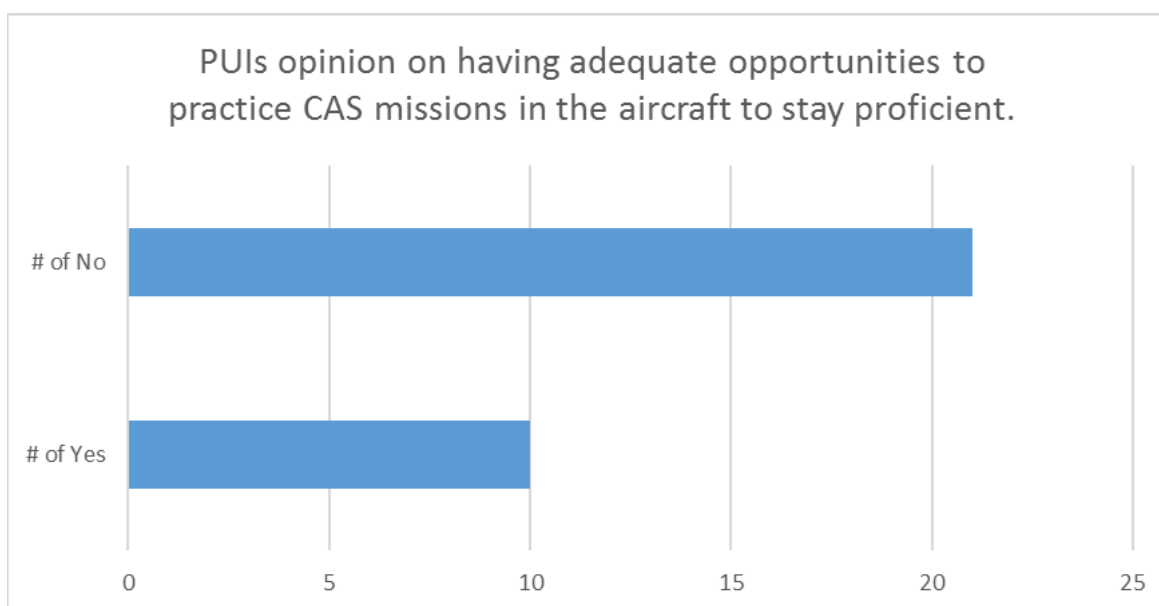
PUIs were then asked if they felt that they had adequate opportunities to practice CAS missions in the aircraft to stay proficient; Table 7 and Figure 10 show their answers. Over two-thirds of the PUIs said they did not have adequate opportunities to practice CAS missions in the aircraft to stay proficient. Even more interesting is that 19 out of the 22 survey responses from PUIs on the East Coast indicated they did not have adequate opportunities to practice CAS missions in the aircraft to stay proficient. More detailed research would need to be conducted to determine if there are significant differences in PUIs training opportunities between geographic locations of HMLA units.

PUIs were also asked to list top three difficulties they experienced during the conduct of their first CAS flight. Similarly, IPs were asked to list the top three difficulties that, in their opinion, PUIs experienced during their first CAS flights. Figure 7 compares the PUI responses with the IP responses.

Table 7. Having Adequate Opportunities in Aircraft to Stay Proficient

PUI opinion of having adequate opportunities to practice CAS missions in the aircraft to stay proficient				
	Yes	No	Not responded	TOTAL
#	10	21	0	31
% of Total (= % of responses)	32.26	67.74	0.00	100.00

Figure 10. Having Adequate Opportunities in Aircraft to Stay Proficient

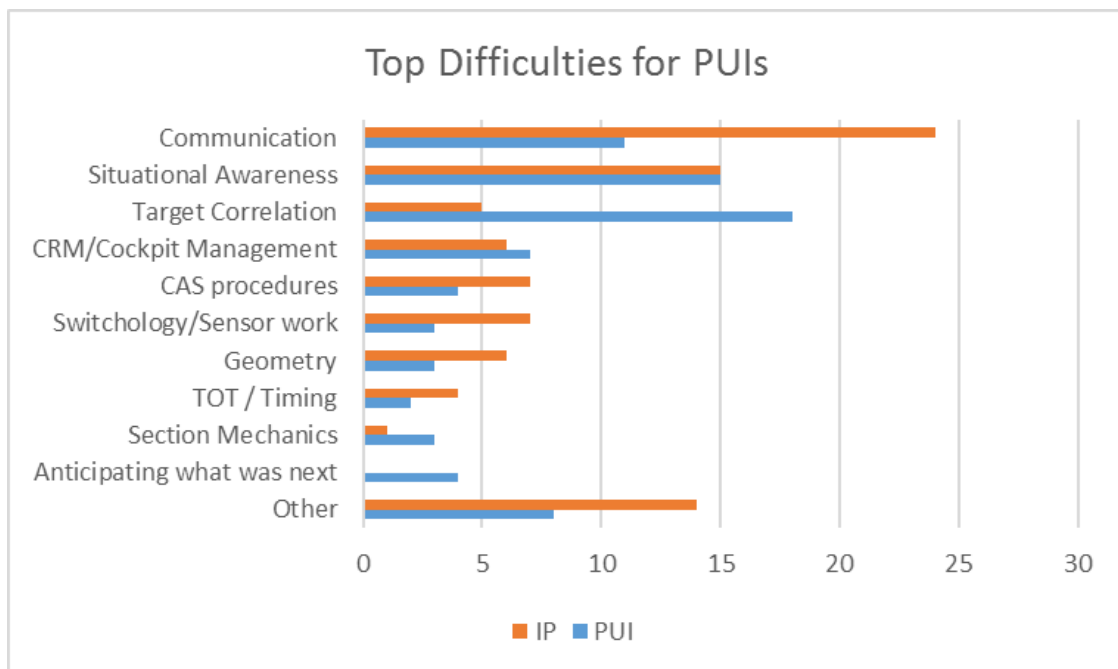


The results presented in Table 8 and Figure 11 clearly suggest that communication, situational awareness, and target correlation are top three types of difficulties that PUIs experience during their first CAS flights.

Table 8. Top Difficulties

Top three difficulties for PUI during first CAS flight		
	PUI	IP
Anticipating what was next	4	0
Section Mechanics	3	1
TOT / Timing	2	4
Geometry	3	6
Switchology/Sensor work	3	7
CAS procedures	4	7
CRM/Cockpit Management	7	6
Target Correlation	18	5
Situational Awareness	15	15
Communication	11	24
Other	8	14

Figure 11. Top Difficulties for PUIs during First CAS Flight





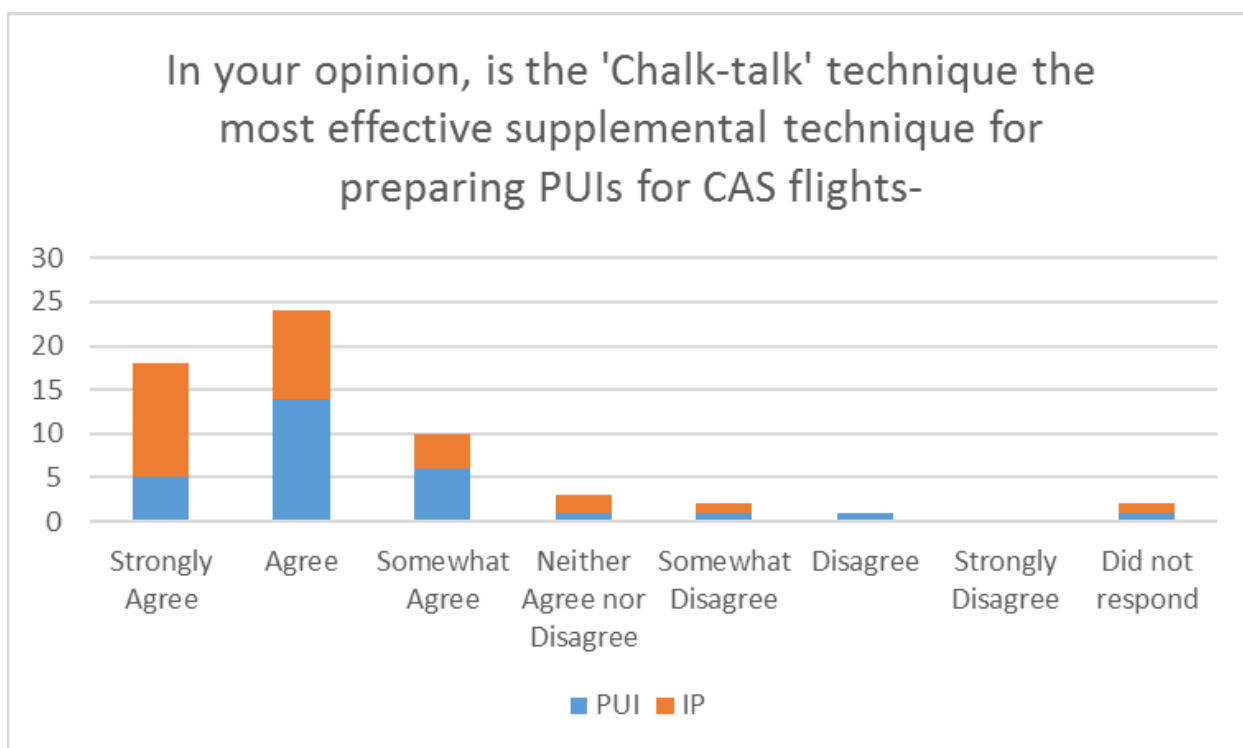
While IPs and PUIs were presented with the same question, it is worth noting that PUIs listed “target correlation” more than any other difficulty (18 times selected), while the same issue was selected only five times by IPs. Additionally, “Anticipating what was next” was not mentioned by IPs at all. More detailed research would need to be conducted to determine what the root cause is of the difficulty experienced by PUIs during their first CAS flights. The analysis of the survey data in this section helped us determine that the prototype trainer should also include a communication capability.

PUIs and IPs were asked if they thought chalk talks were the most effective supplemental technique for preparing PUIs for CAS flight; Table 9 and Figure 12 summarize these results. The majority of IPs and PUIs agreed at some level that chalk talks were the most effective supplemental technique for preparing PUIs for CAS flights.

Table 9. Opinion of Chalk Talk Effectiveness by PUI and IP

In your opinion, is the 'Chalk-talk' technique the most effective supplemental technique for preparing PUIs for CAS flights		
	PUI	IP
<b>Strongly Agree</b>	5	13
<b>Agree</b>	14	10
<b>Somewhat Agree</b>	6	4
<b>Neither Agree nor Disagree</b>	1	2
<b>Somewhat Disagree</b>	1	1
<b>Disagree</b>	1	0
<b>Strongly Disagree</b>	0	0
<b>Did not respond</b>	1	1

Figure 12. Opinion of Chalk Talk Effectiveness by PUI and IP

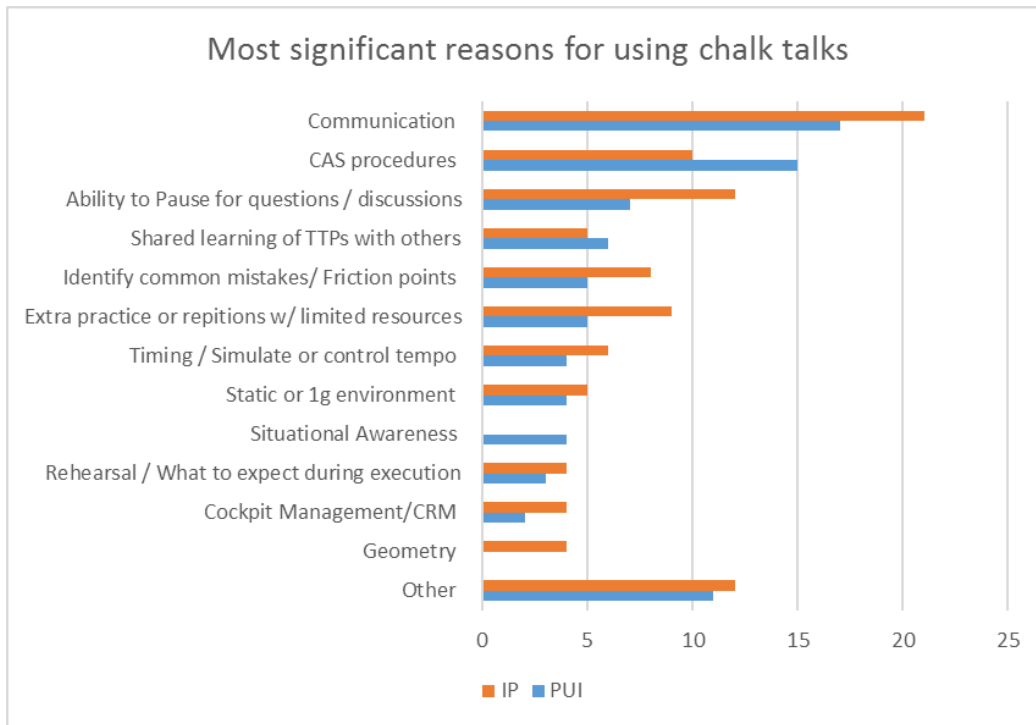


Opinion of chalk talk effectiveness was consistent between both PUI and IP. Both PUIs and IPs were also asked what they thought was the most significant reasons for using chalk talks; Table 10 and Figure 13 present these results.

Table 10. Most Significant Reason IPs and PUIs Use Chalk Talks

Most significant reasons for using chalk talks		
	PUI	IP
Communication	17	21
Ability to Pause for questions / discussions	7	12
CAS procedures	15	10
Extra practice or repetitions w/ limited resources	5	9
Identify common mistakes/ Friction points	5	8
Timing / Simulate or control tempo	4	6
Static or 1g environment	4	5
Shared learning of TTPs with others	6	5
Geometry	0	4
Cockpit Management/CRM	2	4
Rehearsal / What to expect during execution	3	4
Situational Awareness	4	0
Other	11	12

Figure 13. Most Significant Reason IPs and PUIs Use Chalk Talks



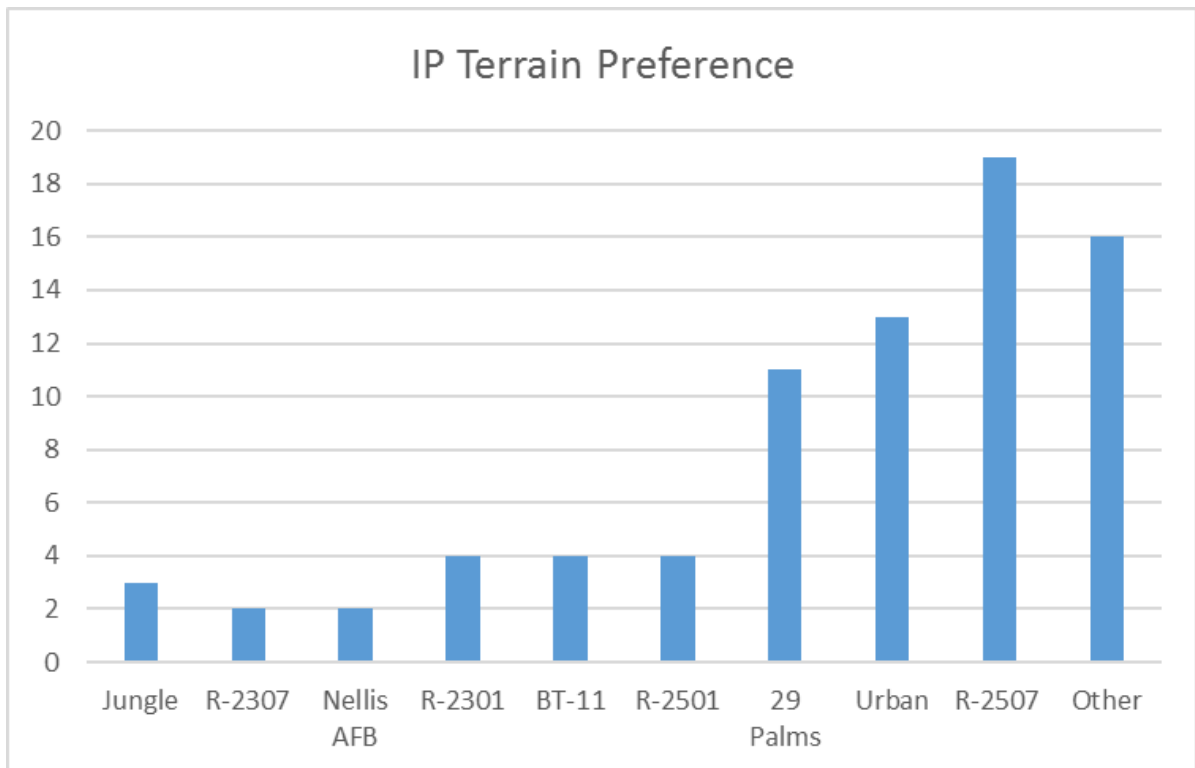
The collected data suggest that majority of PUIs and IPs agree the communication is among the top difficulties PUIs experience during their first CAS flight. They also agree that a chalk talk is currently the most effective supplemental technique that is available to PUIs for training of CAS flights. Communication skills were the most referenced reason among PUIs and IPs when asked what their most significant reason for using chalk talks where. This information reinforced a decision related to part-task trainer design—allowing IPs to incorporate radio calls of their choosing was overwhelmingly judged by both communities as very much needed.

The survey also collected information about the regions or training areas that IPs would prefer to use when they develop scenarios for PUIs. Results presented in Table 11 and Figure 14, clearly indicate that R-2507 near Yuma, AZ was the most preferred choice of terrain for scenario development. Urban terrain was the second most desired type, and terrain in Twentynine Palms was the third most desired.

Table 11. Preference of Regions or Terrain for Scenario Development

IP recommended terrains	
Type of terrain	# of responses
Jungle	3
R-2307	2
Nellis AFB	2
R-2301	4
BT-11	4
R-2501	4
Twentynine Palms	11
Urban	13
R-2507	19
Other	16

Figure 14. Preference of Regions or Terrain for Scenario Development



Due to the complexity and time-consuming nature of building an urban terrain, it was ruled out for the prototype. Since units from all geographic locations rotate through Twentynine Palms for Integrated Training Exercises (ITX), Twentynine Palms terrain was chosen for the initial version of the prototype; R-2507N and R-2507S were selected as the secondary terrains. The “Other” section included terrain that applied to each major OPLANS, shipboard operations, Middle Eastern terrain, and several other more specific unique range areas.

Lastly, the preferences of the type of training device to be used by PUIs in part-task trainer was collected from both PUIs and IPs. Table 12, Table 13, and Figure 15 shows that a virtual sand table setup (12) and tablet (12) were two most preferred devices by IPs. PUIs preferred a virtual sand table the most (11), followed by a tablet (6), laptop (6) and desktop device (5).

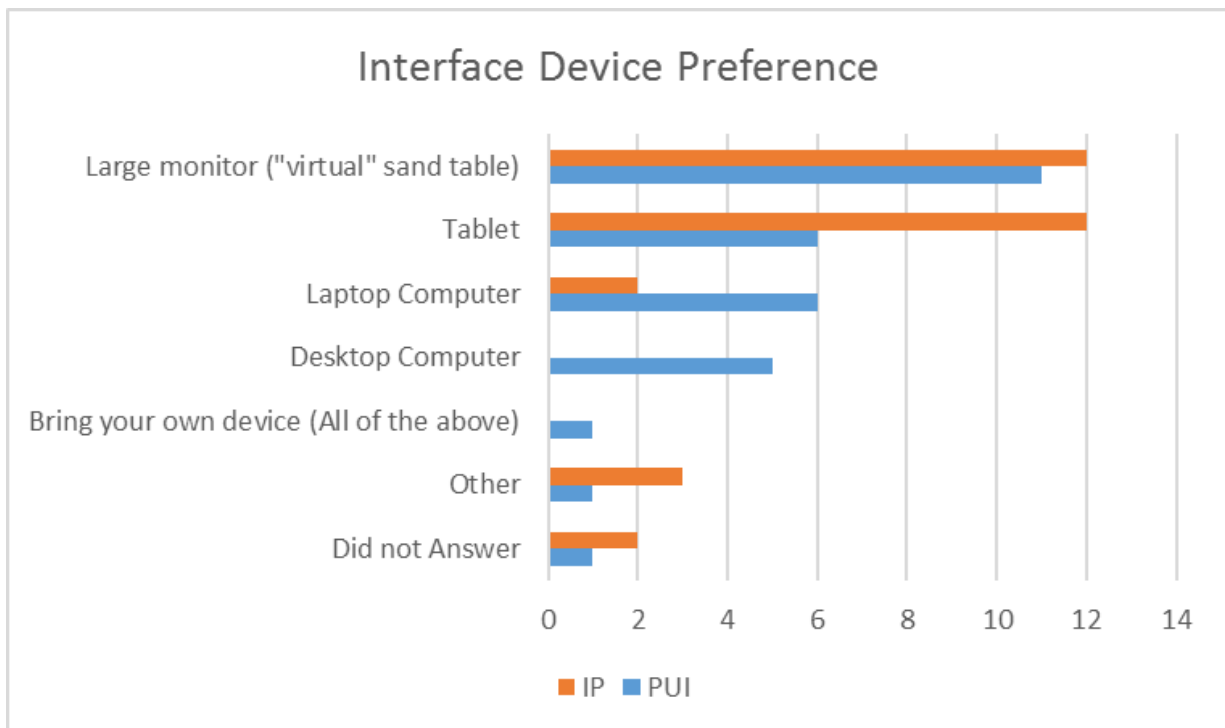
Table 12. Preference of Training Device, PUIs

Preference of training device		
	# of PUIs	% of PUIs
<b>Computer with large monitor (like a "virtual" sand table)</b>	<b>11</b>	<b>35.48</b>
<b>Tablet</b>	<b>6</b>	<b>19.35</b>
<b>Laptop Computer</b>	<b>6</b>	<b>19.35</b>
<b>Desktop Computer</b>	<b>5</b>	<b>16.13</b>
<b>Bring your own device (All)</b>	<b>1</b>	<b>3.23</b>
<b>Other</b>	<b>1</b>	<b>3.23</b>
<b>Did not respond</b>	<b>1</b>	<b>3.23</b>

Table 13. Preference of Training Device, IPs

Preference of training device		
	# of IPs	% of IPs
<b>Computer with large monitor (like a "virtual" sand table)</b>	<b>12</b>	<b>38.71</b>
<b>Tablet</b>	<b>12</b>	<b>38.71</b>
<b>Laptop Computer</b>	<b>2</b>	<b>6.45</b>
<b>Desktop Computer</b>	<b>0</b>	<b>0.00</b>
<b>Bring your own device (All)</b>	<b>0</b>	<b>0.00</b>
<b>Other</b>	<b>3</b>	<b>9.68</b>
<b>Did not respond</b>	<b>2</b>	<b>6.45</b>

Figure 15. Preference of Training Device (PUIs and IPs)



## **E. CHAPTER SUMMARY**

This chapter discusses the details of the user study (online survey) conducted with the IP and PUI. Collected data set was used to gather information that was used to better inform the design and development of the prototype part-task trainer. Looking at what attributes of supplemental training techniques were perceived as being the most effective, we were able to expand initial idea of combining the training benefits of chalk talks and chair flying into a single computer based training solution.



## **VII. PROTOTYPE SYSTEM**

### **A. INTRODUCTION**

The development of the prototype part-task trainer included testing different approaches and using different infrastructure to build virtual environment.

### **B. TESTED OPTIONS**

#### **1. Virtual World Sandbox**

The Virtual World Sandbox from Advanced Distributed Learning (ADL) was the first development tool that was tested for the prototype part-task trainer. The tool was developed by the U.S. government and did not require any additional licensing fees. Additional benefit is that it utilizes JavaScript and has a native capability for After-Action Reviews (AAR). It also offers the ability to be cloud-based, a feature that was advantageous for hosting a repository of scenarios and allowing multiple IPs to contribute remotely to the development of a scenario. However, one drawback of being cloud-based was that the PUI would require Internet connectivity in order to conduct training session. While this would be acceptable in many applications, it was determined that the prototype needed to be able to run as a stand-alone application without the Internet connectivity. Additionally, the initial use of the Virtual World Sandbox was not stable (system was slow and crashes were too frequent), and it was determined that it would not be preferred choice of the tool for the prototype part-task trainer.

#### **2. Google Earth**

Google Earth was the next tool that was examined for its suitability of serving as the potential basis for the prototype. The tool already has an embedded capability of a virtual fly-through mode across the entire globe. Additionally, it uses KML file format to create waypoints and overlays, which is also used by mission planning software on tablets such as KILSWITCH. This tool

would potentially alleviate the issue of manually creating the scenario information as the same information is already created with mission planning tool. Initial progress with Google Earth seemed promising, however the Google Earth API was deprecated and turned off on December 12, 2015. This made it much more difficult to embed radio calls and pop-up quiz questions in the scenario. In the end it was determined that Google Earth could not serve as the basis for building the prototype training system.

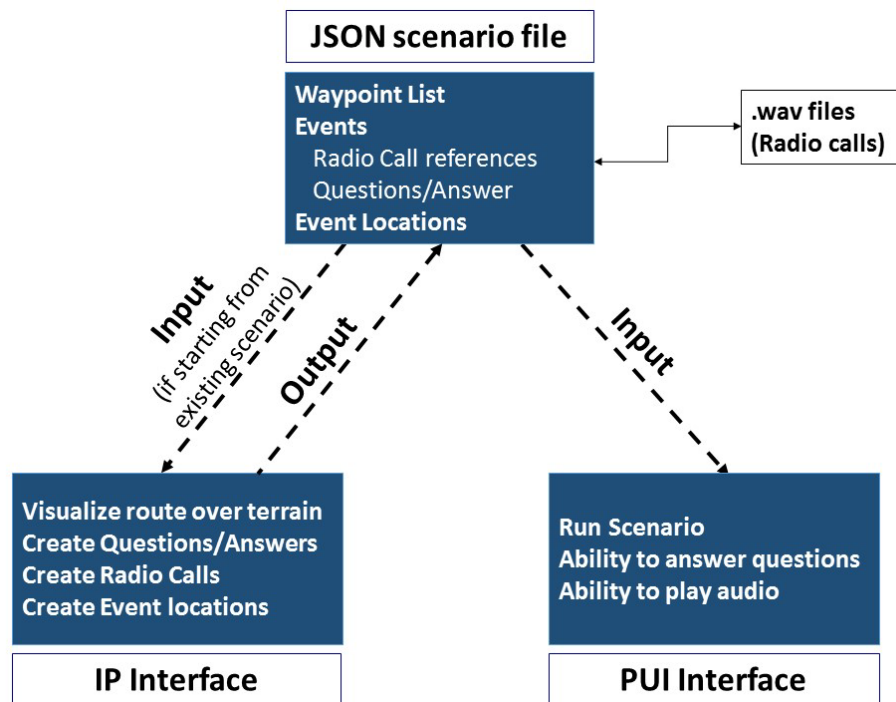
### **3. Unity Game Engine**

Unity game engine was also looked at as a potential system for developing the prototype part-task trainer. It was judged as very flexible and with a great online technical support, resources, as well as plug-ins from its “Asset store.” Additional benefit was the fact that Unity allows applications to be built for a wide variety of operating systems, including Windows, iOS, Android, and others. This was highly desirable because once the interface is designed in Unity, one would have the ability of building it for whatever device and operating system might need to be supported. All those advantages made this tool to become the tool of choice for development of the prototype training system.

## **C. SYSTEM ARCHITECTURE**

The prototype training system needed to allow IPs to build and save scenarios that could then be used by PUIs. In order to support this capability, the scenario data along with the associated audio files was saved in a file using JavaScript Object Notation (JSON) format. Figure 16 shows how the IP interface, scenario file, and PUI interface are related.

Figure 16. Software System Architecture



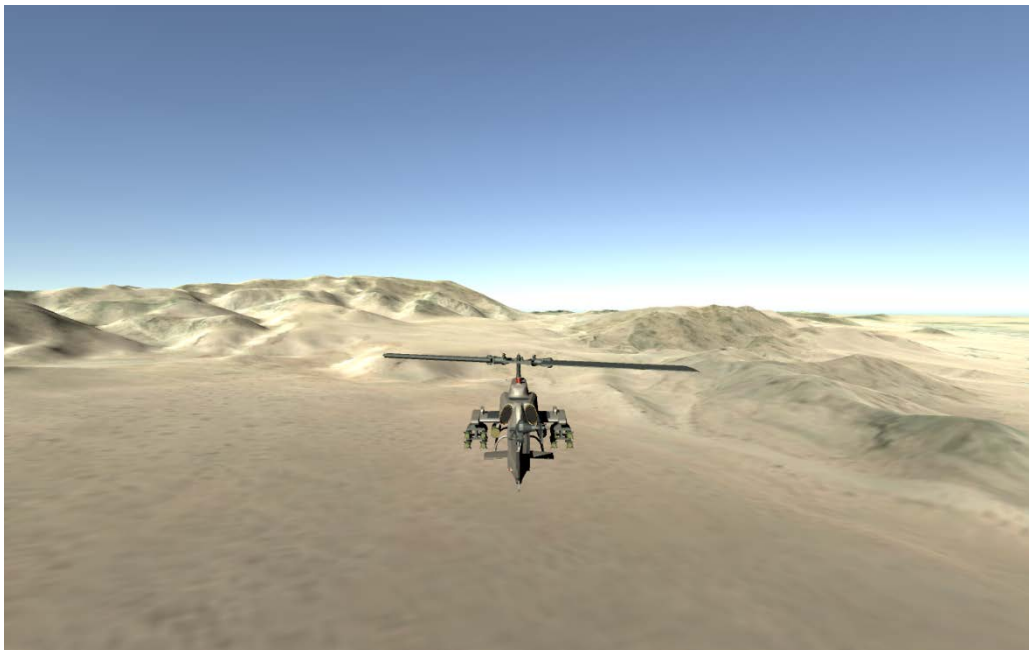
#### D. PROGRAMMING AND DEVELOPMENT ENVIRONMENT

Initially, terrain depicting Twentynine Palms was created using the WorldComposer asset. This terrain served as a basis for both the IP and PUI interface. The PUI interface was the first segment that was developed to test the basic functions of the future training system. The aircraft model used for this interface was an AH-1W Super Cobra; this 3D model was acquired through the MOVES Scenario Authoring and Visualization for Advanced Graphical Environments (SAVAGE) repository (Figure 18). The model used, was comprised of 26,247 vertices and 28,558 faces. The model could easily be swapped out with different Type Model Series (TMS) aircraft models for use in the PUI interface (Figure 19).

Figure 17. AH-1W Super Cobra Model



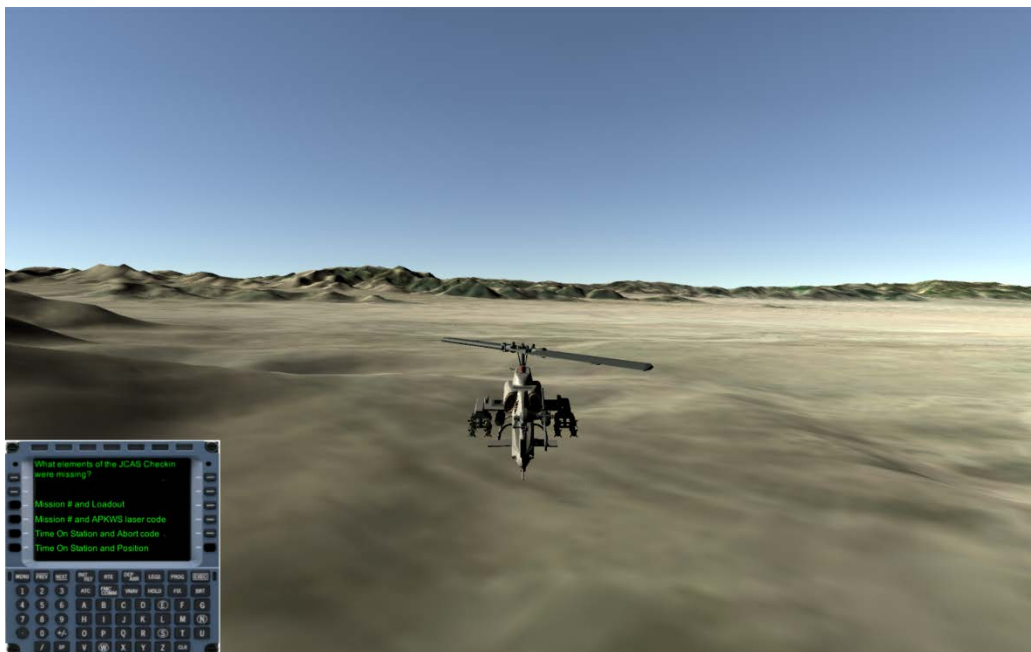
Figure 18. AH-1W Super Cobra Model in PUI Interface



The flying route was created in Unity by converting the waypoints from Latitude & Longitude to the coordinate system in Unity and assigning each leg of the route a unique segment ID. This allowed the instructor to create event

locations at different points along the desired route; any event location could have either a radio call or a pop-up question assigned to it. Once created the event location is treated as a non-visible object in the scene. During execution of the training scenario, when the aircraft object detects a collision with an event location, it triggers the event (radio call or pop-up question) associated with that event location. The lower left corner in Figure 19 shows a pop-up question displayed on the PUIs screen.

Figure 19. Pop-Up Question Event (PUI Interface)



By accepted interaction convention, the automated aircraft forward movement is paused until the question is answered and the 'Continue' button is selected by the PUI.

Once the elements of PUI interface were fully resolved, the effort shifted toward getting the scenario information saved in JSON file—this was to be done by using capabilities of IP interface. This allowed very much needed flexibility in creating a training scenario by the instructor—if all details are saved in a file, the elements of scenario could be easily changed without a need to change the C#

scripts in Unity. At this point the IP User Interface was developed. It was decided that the interface would use two different views of the terrain to depict the route. As seen in Figure 20, the lower left side quadrant in the interface provides a top down view, while the lower right side quadrant provides an adjustable viewing position and angle.

Figure 20. IP User Interface



The IP interface also has a scrollable window just above the terrain view—this part of the interface depicts the route segments as a straight line. The IP can select a position anywhere along one route segment and use it as an event location for that route segment. Additionally, the interface allows the user to record and uniquely name radio calls; the same radio calls can be used to define events in scenario.

Figure 21 shows the process of creating a pop-up question by selecting “Create Question Text” button. Once the pop-up window appears, the IP can type in the question text, and add up to four multiple choice answers. This allows IPs flexibility in how many options are presented to the PUI, while being mindful that

the application may be built to run on a smart phone or tablet where there might be limited amount of space to display more than four possible answers. The check boxes on the left side of the answers allow the user to check the single correct answer (Figure 21). The current configuration only allows one correct answer to be selected. This is not to say that an IP would not be able to create an “All of the above” type of answer selection to overcome this issue though.

Figure 21. “Create Question Text” Pop-Up Window

Where is Havoc 23 currently located at?

☐ OP Bullion West

☐ MSR Ennis

☒ OP Bullion East

☐ CP Alfred

Save Cancel

Once the IP is finished with creating all elements of the scenario, the JSON file can be uniquely named and saved. The same file and the folder with the associated .wav files is what is distributed and made available to the PUIs for their use.

## E. CHAPTER SUMMARY

This chapter describes approaches that were explored and used to design and build the prototype part-task trainer, including the final selection of Unity

game engine. The elements of two types of interface are described, as well as interaction techniques used by IPs and PUIs to accomplish their respective tasks.



## **VIII. FEASIBILITY TESTING AND ANALYSIS OF RESULTS**

### **A. INTRODUCTION**

This chapter discusses the details of the feasibility study that was conducted and the associated feedback from it. The study was based on feedback from an informal demo conducted with a Marine helicopter squadron while they participate in an Integrated Training Exercise (ITX).

### **B. SYSTEM PERFORMANCE**

The initial prototype was built as a Windows application and was run on a Window Surface Pro 3 running Windows 10, 64-bit operating system. The Surface Pro 3 has an Intel Core i5-4300 CPU with 8GB of ram.

The scene in Unity consisted of terrain from the 29 Palms area that covered a 64.5 km by 64.5 km square. With this terrain and a single animated helicopter, the average framerate was between 44 and 60 frames per second (FPS), with the lowest observed of 38 FPS. The system was run using the touchscreen capabilities of the Surface Pro 3, as well as with wirelessly connected mouse. An Android build is currently being tested as well.

### **C. INFORMAL DEMO FEEDBACK**

An informal demo was conducted with a group of pilots from HMLA-269 while they were at Twentynine Palms, CA attending an Integrated Training Exercise (ITX). During the first meeting, a squadron IP used the IP interface to help build a scenario. The second meeting was organized with a group of five pilots (two IPs and three PUIs); they were given opportunity of experiencing the scenario as it would be presented to a PUI via PUI interface. The demo was conducted in a classroom environment with the visual interface (display) being projected on a large screen (Figure 22.) The screen resolution was set to 1440 x 900 for the demonstration and connected to an ASUS 23" monitor for a portion of

the scenario development. PUI interface demonstration used a projector to be able to show the interface to the small group of PUIs.

Figure 22. PUI Interface Demo



The demo presented to the pilots also included a presentation of how the IP interface was used to create a scenario as seen (Figure 23.)

Figure 23. IP Interface Demo



## 1. IP Feedback

The responses and suggestions from IPs can be categorized in several groups:

- **Choice of training platform:** The main feedback received from the IPs was related to the process of fielding the application if it were to become a program of record. The concern was that it would be tied to a specific stand-alone type of device that would need to be checked out or require civilian contractor support to create scenarios. It was believed that this issue of access and the choice of platform on which it would be installed, would reduce the benefit of prototype training capability. An alternative of allowing users to use their own device (which they may prefer and have it already incorporated into their daily life), was judged to be much better option.
- **Scenario repository:** IPs recommended that Marine Aviation Training System Sites (MATSS) serve as the initial places where scenarios would be generated for PUIs. Specifically, IPs referred to MATSS that are located at each of the Marine Corps Air Stations and fall under the Marine Aircraft Wing (MAW) Aviation Training Systems (ATS). These units were perceived as very good groups that could initially help squadron IPs to develop scenarios. Another method that was mentioned was to use the Tactics shops at the squadrons. Those groups could make and submit scenarios to MAWTS-1, and MAWTS-1 could make scenarios available on the MAWTS-1 SharePoint site for downloading via Internet connection.
- **Terrain databases:** The IPs were also interested in the terrain database that would be available for scenario development. Currently, the prototype contains only the terrain for Twentynine Palms. While it is possible to create terrains for different areas by

using WorldComposer in Unity, this is not a type of skillset that would be expected of an IP. Due to data storage limitations on a single training platform (without connectivity to large storage resource), that platform would need to operate with several predefined areas which IPs could select for scenario development.

- **Increasing a level of realism:** IPs were also interested in adding the features which could increase a level of realism. For example, it was suggested to add a capability for the aircraft to actually conduct the attack, and to visualize the impacts and smoke generated from weapons systems. This type of visualization could be accomplished by modeling and building several pre-determined aircraft behaviors that IPs could select during scenario development. Example behaviors might include; left-hand holding, right-hand holding, diving attack, low-altitude pop attack, etc. Each of these behaviors could be selected and assigned a Latitude-Longitude point and a duration if appropriate.
- **Text-to-speech converter:** A recommendation to implement a text-to-speech converter for scenario input was also suggested. This would allow IPs to utilize scenarios that they have already typed up for use in the aircraft, without the need to record the calls themselves using different voices to add realism. However, current text-to-speech applications may detract from the realism of the scenario, as it may be difficult to incorporate realistic sounding human voices and produce voice inflections and pitch in the communication calls that IP may deem needed for given scenario.
- **Support for different mission sets:** Lastly, IPs mentioned a need to support different mission sets. More specifically they had in mind the Strike Coordination and Reconnaissance (SCAR) and Armed Reconnaissance (AR). Those type of mission sets also bring

difficulty for PUIs: while execution them PUIs need to keep up with a number of assets and the amount of communication traffic that is often involved in the area. It is estimated that more research would need to be conducted to investigate potential benefits of using this system for other mission sets including SCAR, AR, Escort, Assault Support, etc.

## **2. PUI Feedback**

The responses and suggestions from PUIs can be categorized in several groups:

- **Build a smart pack:** One suggestion from the PUIs was build a smart pack that would complement a given scenario. This smart pack could include some of the typical documents that are made during mission planning for actual flights. For example, a coversheet that might include callsigns, frequencies, timelines, etc. Another product in the smart pack might include an Objective Area Diagram (OAD) which graphically depicts Airspace Coordination Measures (ACM), friendly or enemy positions, phase lines, etc. Adding these products to the scenario would help PUIs conduct their training in a manner of doing it in the aircraft or simulator. Additionally, such smart pack could help with cockpit management techniques as well.
- **Support for smaller subset of training evolution:** Another suggestion from PUIs was to not just use the system for the CAS mission, but also use it for smaller subsets of training evolutions which may occur before or during the conduct of a CAS mission. For example, the suggestion was to demonstrate how a radio or Tactical Video Down Link (TVDL) RIO would sound on the radio, or how contingencies such as a Buddy Lase would sound on the radio. IPs could build scenarios that have added type of interaction:

the execution of the scenario could be paused to give the PUI an opportunity to respond and suggest as how he (she) thinks the radio call should sound. PUI could then select 'Continue' button and actually hear what the correct version of the call should sound like.

- **Multi-Functional Displays (MFD) and Moving Map display:** PUIs also suggested adding interface features such as a moving map or Multi-Functional Displays (MFD). The focus of this part-task trainer was to limit the amount of aircraft specific systems that a PUI would need to interact with while learning the basics of CAS procedures. While these could be added, it would also drive the necessity for scenarios to become more aircraft specific since each aircraft has different system displays and capabilities.
- **Support different models of the aircrafts:** Additional suggestion was to change the model of the aircraft to reflect different TMS aircraft in the squadrons. As mentioned previously, this would not be difficult to add to the current prototype.

#### **D. CHAPTER SUMMARY**

This chapter discusses the elements of feasibility study and comments received upon the demonstration of the prototype for a small group of IPs and PUIs. The suggestions collected in this informal study could be used to help inform future work, and be a basis for refinements of the prototype interfaces and new system features.

## IX. CONCLUSIONS AND RECOMMENDATIONS

### A. CONCLUSION AND RECOMMENDATIONS

This chapter provides a summary and conclusion of the study focused on feasibility of using commercial off-the-shelf components to develop a prototype part-task trainer in support of close air support training.

This thesis sought out to answer the following questions:

- *Is there a gap in training between the required academic courseware and the simulator/flight events in the close air support syllabus for Marine Light Attack Helicopter Pilots?*

Analysis of self-reported data collected in user survey from PUIs and IPs, suggest that majority of difficulties experienced by PUIs early in the syllabus are concerned with communications and CAS procedures. If there is a training gap, current methods of supplemental instruction such as chalk talks are seen as effective means of reducing the effects of such gap. More specific research would need to be conducted to develop a metric for evaluating PUI performance during the early CAS stage events in both simulator and aircraft, and determine if there is an actual gap in training. It is of note that a training gap could be attributed to different causes. Notably this training gap could be specific to certain regions due to varying levels of resource availability, or it could be attributed to situation where a full skill set needed to conduct successful training in simulator has not been acquired yet.

- *What type of supplemental academic tools and approaches are instructors using in training of USMC pilots for close air support operations?*

Data collected in the online survey suggest that chalk talks and formal quizzes/tests are the most widely used in HMLA squadrons. Chalk talks were also considered the most effective supplemental training techniques used by the pilots.

- *What is the feasibility of developing a prototype virtual reality (VR) system that could support training of close air support Procedures?*

The research conducted in support of this thesis demonstrates that it is possible to develop a part-task trainer using commercial off-the-shelf (COTS) systems and VE to support training of CAS procedures and communication. The choice of using Unity game

engine with the support of several plugins, enabled the development of this training system on Windows, Android, iOS, or any other operating systems supported by Unity software. This allows PUIs to install the trainer on a range of devices they may have themselves. They can also practice CAS communications and procedures at their own pace and as many times as they feel necessary. One necessary part of training environment is a scenario (or scenarios) built by an IP; once built this scenario can be used by many PUIs. IPs can, but do not have to be present to lead the training evolution with this part-task trainer. The capabilities integrated in this trainer effectively combine the benefits of a “chalk talk” (done with assistance of IP) with the benefits of “chair flying” (done by the pilots while practicing alone).

## **B. FUTURE WORK**

The following aspects of the prototype that could be improved with future work:

- **Increase Terrain Database:** The number of available terrain options for IPs to create scenarios could be increased. This could be done by incorporating several predetermined and pre-loaded regions that would automatically come with the application. Alternatively the terrain could be stored with the JSON scenario file and either stored on a portable storage device or on a shared repository (server), and accessed when needed.
- **Improvements of IP Interface:**
  - **Event timeline graphical depiction** – Current user interface does not display event duration on the route. A problem may arise when creating events that must be very close to each other but without overlapping. This could be overcome by basing the prefab's size off of the duration of the radio call or event. Additionally, the timeline could include visualization of multiple events that run concurrently. This would allow for a more complex scenario that could replicate the reality of aircraft receiving radio calls over multiple radios simultaneously; IPs could enter section or division specific radio calls and overlay them in the complex scenario.
  - **Route waypoint selection** – Interface could allow an IP to build or modify the route. In current instantiation of the interface functionalities, the route is loaded in from the JSON file and cannot be modified from the interface.



- **KML input for scenario** – IP should be able to input scenario information directly from a KML file built using KILSWITCH or Google Earth. This would be a time saving feature that would allow IPs to utilize routes and control measures that have been built already. The current system uses Latitude and Longitude which is consistent with the format used in KML files.
- **Text-to-speech radio call input** – Depending on the accuracy and robustness of text-to-speech applications, it could be possible to add functionality similar to the “Create Question Text” pop-up window and allow IPs to add radio calls simply by typing. Additionally, the level of realism would be increased if different type of voices could be added to the radio calls (unique sounding personalities for the different role players.)
- **Assessment output format** – The current configuration of training system provides instantaneous feedback to questions presented in the scenario. Alternatively, the answers received from PUIs could be saved to a separate file. At the end of the training session PUIs could review this file, get a full account of their mistakes and discuss them with IPs. The same information could be saved and compared with the results of PUIs performance in different scenarios, when possible trends in one’s performance could be examined.
- **Intelligent tutoring** – It is possible that intelligent tutoring techniques could be built in to the part-task trainer to allow IPs to determine how they want the scenario to unfold depending on how a PUI is performing. This could help adjust the level of difficulty in real-time for the PUI.
- **Usability study** – Conduct formal usability study with focus on IP and PUI interfaces. The study would examine learnability, effectiveness, efficiency and user satisfaction with both user interfaces.
- **Training Effectiveness Study** – Design and conduct formal training effectiveness study to test the training benefits of part task trainer. Additional research could be done to determine how well PUIs perform on their first simulator and flight events after using the part-task trainer versus PUIs who do not use the system.
- **Examine Support for Other Mission Sets** – Other mission sets, such as SCAR, AR, Escort, and Assault Support, could also be supported by the same general approach used in this CAS part task trainer. Additionally, the system could be used to demonstrate course rules for entry/exit into airfields.

## **C. CHAPTER SUMMARY**

This chapter summarizes the research designed to investigate a feasibility of developing a part-task trainer prototype for CAS procedures. The text reviews major conclusions and directions for future work. The findings of this effort suggest that it is possible to build a Computer Based Rehearsal and Assessment (COBRA) Trainer that could be used to help increase pilot proficiency with communications and procedures in a multitude of mission sets. It is important to note that this training system is not designed to serve as a replacement for current training methods. Rather, it is seen and recommended as an additional training resource available to the PUIs to help them perfect their procedural and communication skills, and get better prepared for training events conducted in the full motion simulator and aircraft.

# APPENDIX: SURVEYS

## 1. Consent

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

**Naval Postgraduate School Consent to Participate in Research**

**AUTHORITY:** 10 U.S.C. 5013; 10 U.S.C. 5041; 10 U.S.C. 1074f; 32 CFR 64.4; DoD Instruction 1215.13; DoD Instruction 3001.02; CJCSM 3150.13C; DoD Instruction 6490.03; SECNAVINST 1770.3D; MCO 7220.50B; and E.O. 9397 (SSN), as amended.

**Introduction.** You are invited to participate in a research study entitled Proof-of-Concept Part Task Trainer for Close Air Support Procedures". The purpose of this research study is to investigate the current techniques used to train Close Air Support procedures.

**Procedures.** You will be asked to answer several questions utilizing an online survey tool called LimeSurvey. The survey is focused on your experiences and understandings of current Close Air Support training techniques. The surveys should take approximately 30 minutes to complete.

**Location.** The survey will be conducted online.

**Cost.** There is no cost to participate in this research study.

**Voluntary Nature of the Study.** Your participation in this study is strictly voluntary. It is important to know that if you choose to participate, then you can change your mind at any time and withdraw from the study. You will not be penalized in any way or lose any benefits to which you would otherwise be entitled if you choose not to participate in this study or to withdraw. The alternative to participating in the research is to not participate in the research.

**Potential Risks and Discomforts.** There is a minimal risk of breach of confidentiality and the survey process does not involve greater than minimal risk.

**Anticipated Benefits.** Anticipated benefits from this study are for the Marine Corps and any other services that conduct Close Air Support missions using joint doctrine. Data collected will help to in identifying methods to effectively use virtual environments for the conduct of a part task trainer within the Close Air Support mission set. You will not directly benefit from your participation in this research.

**Compensation for Participation.** No tangible compensation will be given.

**Confidentiality & Privacy Act.** Any information that is obtained during this study will be kept confidential to the full extent permitted by law. Information collected will be removed from LimeSurvey and stored by the Principle Investigator. All efforts, within reason, will be made to keep your personal information in your research record confidential, but total confidentiality cannot be guaranteed. No information will be publicly accessible that could identify you as a participant. You understand that records of your participation will be maintained by NPS for ten years.

**Points of Contact.** If you have any questions or comments about the research, or you experience an injury or have questions about any discomforts that you experience while taking part in this study please contact the Principal Investigator, Dr. Amela Sadagic, (831) 656-3819, asadagic@nps.edu. Questions about your rights as a research subject or any other concerns may be addressed to the Navy Postgraduate School IRB Chair, Dr. Larry Shattuck, lgshattu@nps.edu.

\* **I**

**Statement of Consent.** I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

**Check any that apply**

☐ I consent to participate in the research.

☐ I do NOT consent to participate in the research.

## 2. IP Survey

### IP Survey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

#### User Information

**\* What is your current billet?**  
Choose one of the following answers

☐ MAWTS IP

☐ Squadron WTI

**\* Select which geographic location you have spent the most time instructing at as a squadron WTI?**  
Choose one of the following answers

☐ East Coast

☐ West Coast

☐ Hawaii

**This survey is currently not active. You will not be able to save your responses.**

## IP Survey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

### Close Air Support Stage Questions

Please answer the following questions based on your past experiences of conducting Close Air Support (CAS) flights with Pilots Under Instruction (PUIs) who were being evaluated for the first time in the aircraft during the CAS stage (i.e. it is their first flight event in the CAS stage per the T&R manual that is conducted in the aircraft).

\*

**During the conduct of the first flight event in the CAS stage, most PUIs are able to conduct "all missions utilizing CAS procedures and communications" and at a level comensurate with a "2" on a Aviation Tracking Form ("Correct. Recognizes and corrects errors. Requires occasional input from the IP.").**

Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**In your opinion, what were the top three difficulties the PUIs had during these flights? (e.g. PUI had a solid grasp of CAS procedures during the flight brief, but was unable to execute them in the aircraft, or PUI was unable to maintain situational awareness in the objective area, etc.)?**

- 1)
- 2)
- 3)

**List any additional information or comments that relates to trends associated with this stage.**

## IP Survey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

### Supplemental Instruction

Answer the following questions based on your past experiences at the squadron when you were instructing PUIs who were preparing for their first flight event in the aircraft during the CAS stage.

**Which of the following supplemental instructional techniques (ones that are not directly required by the Training & Readiness (T&R) manual) are used in your squadron in order to better prepare junior pilots during the CAS stage?**

**Check any that apply**

- ☐ "Chalk talks"
- ☐ Formal quizzes/tests
- ☐ Supplemental Readings
- ☐ Other:

**\* In your experience, "Chalk-talks" have been the most effective supplemental technique for preparing PUIs for CAS flights.**

Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**If used, how often are "chalk-talks" conducted in your squadron?**

**Check any that apply**

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Other:

**In your opinion, how often should PUIs ideally participate in a "chalk-talk" while preparing for the CAS stage?**

**Check any that apply**

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Other:

List the most significant reasons why you use "chalk-talks."

In your opinion, the following are limitations of "chalk-talks."

Check any that apply

- ☐ Lack of IP availability to lead evolution.
- ☐ Lack of IP availability to create new scenarios/scripts.
- ☐ Lack of access to terrain model, maps, etc.
- ☐ Time constraints for all participating aircrew (Crew Day, Crew Rest, etc).
- ☐ The inability to train large groups at one time.
- ☐ Other:

\* PUIs that performed well on formal quizzes/tests (e.g "Gunrunner University", etc.) performed better in the aircraft during CAS flights, than PUIs who did not perform well on formal quizzes/test.

Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

List the most significant reasons why you think PUIs should be given formal quizzes/tests.

Describe other supplemental instructional techniques that you use or think help PUIs become better prepared to conduct their first CAS flight. This may include things that PUIs do on there own time without direct involvement of an IP (e.g. "chair flying").

## IP Survey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

### Instructor Interface Design

To answer the following questions, imagine you are tasked with designing a new tool to help prepare PUIs for their first flight event in the CAS stage.

For example, you may have a system that would be similar to using the "Route Rehearsal" function in JMPS coupled with the virtual flight view in Top Scene, but with the addition of sample radio calls that would be expected along the route.

Another feature of that tool could be to allow an IP to insert popup questions at various checkpoints or phases of the fight to quiz the PUIs (similar to a "stop tape" and question/answer session during a "chalk talk"). These questions might be configurable in a separate instructor interface that would also be used to input the details of the desired scenario (similar to the "script" that might be used in a "chalk talk"). The PUI would then run the scenario with a separate interface varying levels of difficulty.

\* Check the degree to which you think the features or capabilities listed below are needed to support training of CAS procedures.

	Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
Ability to input radio calls via text	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to record radio calls via microphone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to have pre-built range areas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability for IP to select any real world terrain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Describe any other features or design ideas that you would LIKE that were not previously covered.



**Describe any other features or design ideas that you would DISLIKE that were not previously covered.**

**If the system could have prebuilt ranges or training areas for instructors to create scenarios from, what range or training would be among your top three choices.**

- 1)
- 2)
- 3)

**\* What would be the best hardware platform to support desired functionality of your proposed Instructor interface on? Choose one of the following answers**

- ☐ Computer with large monitor (like a virtual sand table)
- ☐ Desktop Computer
- ☐ Laptop Computer
- ☐ Tablet
- ☐ Smart Phone
- ☐ Other:

[Resume later](#)

[Next](#)

[Exit and clear survey](#)

**This survey is currently not active. You will not be able to save your responses.**

## IP Survey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

### PUI Interface Design

**What major learning and training objectives would you want that system to support?**

**\* For the PUI interface, what features would you want it to have?**

	Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Ability to change view from cockpit to God's eye view	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability for PUI to have the option of a sensor view	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability for PUI to have "free play" mode for PUIs to navigate outside of an actual training evolution	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Describe other features or design ideas that you think would be necessary in the proposed PUI interface.**

**\* What would be the best hardware platform to support your desired functionality and complete your objectives on? Choose one of the following answers**

- ☐ Computer with large monitor (like a virtual sand table)
- ☐ Desktop Computer
- ☐ Laptop Computer
- ☐ Tablet
- ☐ Smart Phone
- ☐ Other:

Resume later

Submit

Exit and clear survey

**This survey is currently not active. You will not be able to save your responses.**

### 3. PUI Survey

#### PUI Survey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

#### User Information

**\* Have you conducted your first flight event in the Close Air Support stage of the Training and Readiness manual?**

☐ Yes ☐ No

**\* Select a geographic location in which you had most of your training since you completed training at the Fleet Replacement Squadron.  
Choose one of the following answers**

☐ East Coast  
☐ West Coast  
☐ Hawaii

**\* Have you ever conducted a CAS flight during training when you were not being evaluated?**

☐ Yes ☐ No

**\* Prior to conducting your first CAS flight for evaluation, had you ever flown in an aircraft that was conducting a CAS mission?**

☐ Yes ☐ No

[Resume later](#)

[Next](#)

[Exit and clear survey](#)

**This survey is currently not active. You will not be able to save your responses.**

## PUI Suvey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

### Close Air Support Stage Questions

The following questions should be based on your experience as a Pilot Under Instruction (PUIs) when being evaluated for the first time in the aircraft during the CAS stage (i.e. the first flight event in the CAS stage that is conducted in the aircraft).

**\***  
During the conduct of the first flight event in the CAS stage, you were able to conduct "all missions utilizing CAS procedures and communications" and at a level comensurate with a "2" on a Aviation Tracking Form ("Correct, Recognizes and corrects errors, Requires occasional input from the IP.").

Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What were the top three difficulties you experienced during this flights? (e.g. I could recite the JCAS checkin during the flight brief, but was not able to transmit it correctly over the radio in the aircraft, or I could not maintain situational awareness in the objective area, etc.)?

- 1)
- 2)
- 3)

List any additional information or comments that relate to trends associated with the CAS stage.



[Resume later](#)

[Next](#)

[Exit and clear survey](#)

This survey is currently not active. You will not be able to save your responses.

## PUI Suvey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

### Supplemental Instruction

Answer the following questions based on your experiences at the squadron while preparing for the first flight event of the CAS stage.

**What type of supplemental instructional techniques (ones that are not directly required by the Training & Readiness (T&R) manual) have been used in your squadron to better prepare junior pilots during the CAS stage?"**

**Check any that apply**

- ☐ "Chalk talks"
- ☐ Formal quizzes/tests
- ☐ Other:

\* **"Chalk-talks" are capable of better preparing PUI's for CAS flights.**

Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* **If used, how often are "chalk-talks" conducted in your squadron?**

**Choose one of the following answers**

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Other:

\* **How often do you think is optimal to participate in a "chalktalk" training while preparing for the CAS stage?**

**Choose one of the following answers**

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Other:

**List the most significant reasons why you use of "chalktalks."**


**In your opinion, the following are limitations of "chalk-talks."**

**Check any that apply**

- ☐ Lack of IP availability to lead evolution.
- ☐ Lack of IP availability to create new scenarios/scripts.
- ☐ Lack of access to terrain model, maps, etc.
- ☐ Time constraints for all participating aircrew (Crew Day, Crew Rest, etc).
- ☐ The inability to train large groups at one time.
- ☐ Other:

**\* Supplemental required readings and/or quizzes (e.g "Gunrunner University", etc.) better prepared you for the CAS stage flights.**

Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Describe other supplemental instructional techniques that you use or think help PUIs become better prepared to conduct their first CAS flight. This may include things that do not involve active participation from an IP (e.g. "chair flying").**

**\* Do you use "chair flying" to help you prepare for CAS procedures and communications?**

☐ Yes ☐ No

**\* "Chair flying" is capable of better preparing PUI's for CAS flights.**

<b>Strongly Agree</b>	<b>Agree</b>	<b>Somewhat Agree</b>	<b>Neither Agree nor Disagree</b>	<b>Somewhat Disagree</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**In your opinion, the following are limitations of "chair flying."  
Check any that apply**

- ☐ Lack examples to practice with.
- ☐ Lack of knowledgeable and experienced individuals to intervene when mistakes are made.
- ☐ Lack of time to conduct.
- ☐ Not realistic enough to provide useful training.
- ☐ Other:

Resume later

Next

Exit and clear survey

**This survey is currently not active. You will not be able to save your responses.**



### PUI Suvey

The purpose of this survey is to gather information about the ways that Close Air Support procedures are taught to Pilots Under Instruction (PUIs) in a HMLA squadron.

0%  100%

#### PUI Interface Design

To answer the following questions, imagine you are tasked with designing a new tool to help prepare PUIs for their first flight event in the CAS stage. For example, you may have a system that would be similar to using the "Route Rehearsal" function in JMPS coupled with the virtual flight view in Top Scene, but with the addition of sample radio calls that would be expected along the route. Another feature of that tool could be to allow an instructor to insert popup questions at various checkpoints or phases of simulated fight to quiz the PUIs (similar to a "stop tape" and question/answer session during a "chalk talk"). These questions and scenarios of varying levels of difficulty would be determined by the instructor (similar to the "script" that might be used in a "chalk talk"). The PUI would then be able run that same scenario." (NOTE: check this same question in IP survey and make this part of the text the same.)

**What major learning and training objectives would you want that system to support?**

\* For the PUI interface, what features would you want it to have?

	Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
Ability to change view from cockpit to God's eye view	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability for PUI to have the option of a sensor view	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Ability  
for PUI  
to have  
"free  
play"  
mode for  
PUIs to  
navigate  
outside  
of an  
actual  
training  
evolution



**Describe other features or design ideas that you think would be good to have.**

**\* What would be the best hardware platform to support your desired functionality and complete your objectives on?  
Choose one of the following answers**

- ☐ Computer with large monitor (like a virtual sand table)
- ☐ Desktop Computer
- ☐ Laptop Computer
- ☐ Tablet
- ☐ Smart Phone
- ☐ Other:

[Resume later](#)

[Submit](#)

[Exit and clear survey](#)

**This survey is currently not active. You will not be able to save your responses.**

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